Section 4
Environmental Stressors

This section describes the significant environmental stressors which impair or threaten water quality in the Chattahoochee River Basin. These include both traditional chemical stressors (such as metals or oxygen demanding waste) and less traditional stressors, such as modification of the flow regime (hydromodification) and alteration of physical habitat. Section 4.1 discusses environmental stressors by source type. Section 4.2 then provides a summary of stressor loads by type of stressor.

4.1 Sources and Types of Stressors

Environmental stressors are first catalogued by type of source in this section. This is the traditional programmatic approach, and provides a match to regulatory lines of authority for permitting and management. Assessment requires an integration of stressor loads across all sources, as described in Section 4.2.

4.1.1 Point Sources

Point sources constitute permitted discharges of treated wastewater to the river and its tributaries, regulated under the National Pollutant Discharge Elimination System (NPDES). These are divided into two main types: permitted wastewater discharges, which tend to discharge at relatively stable rates, and permitted stormwater discharges, which tend to discharge at highly irregular, intermittent rates, depending on precipitation. Non-discharging (land application) waste disposal facilities, which prevent discharge of wastewater effluent to surface waters, are also discussed in this section.

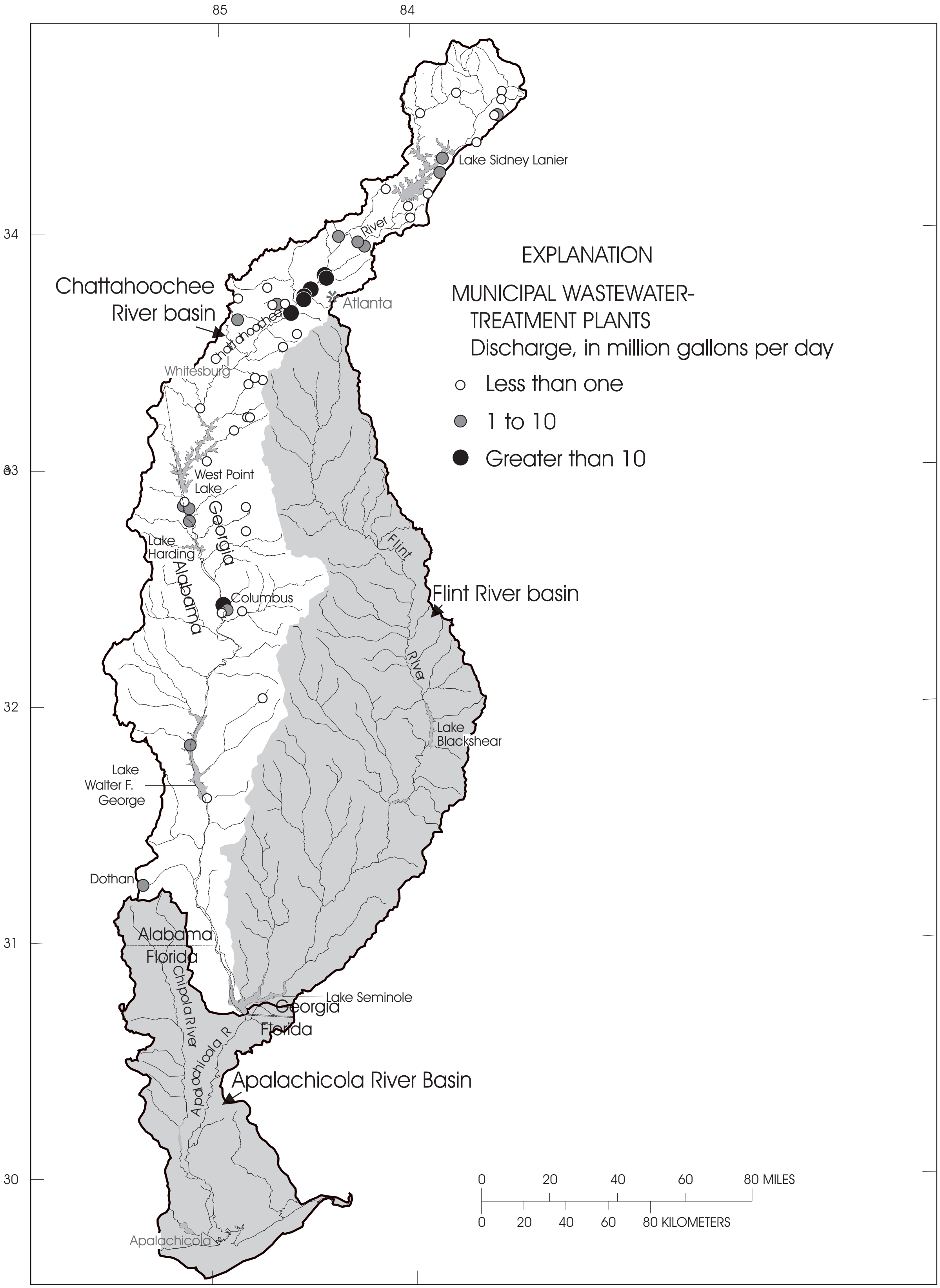
4.1.1.1 NPDES Permitted Wastewater Discharges

Table 4-1 displays the major municipal wastewater treatment plants with permitted discharges of 1 million gallons per day (MGD) or greater in the Chattahoochee River Basin, including wastewater dischargers in the Alabama portion of the basin. (Florida reports no NPDES permits for discharges to surface water within the Chattahoochee River Basin.) The geographic distribution of dischargers is shown in Figure 4-1. In addition, there are discharges from a variety of smaller wastewater treatment plants, including both public facilities (small public water pollution control plants, schools, marinas, etc.) and private facilities (package plants associated with non-sewered developments and mobile home parks) with less than 1 MGD flow. These minor discharges may have the potential to cause localized stream impacts, but are relatively insignificant from a basin perspective.

Approximately 326 MGD of treated wastewater is currently discharged from water pollution control plants in Georgia into the Chattahoochee River or tributaries by permitted point source discharges, including municipal and industrial sources. Alabama contributes another 16.5 MGD of treated wastewater. About 74% of the Georgia discharges occur in the metropolitan Atlanta area (to the lower portion of HUC 03130001 and upper portion of HUC 03130002). While the river provides a means to assimilate these treated wastewaters, the discharges are sources of a variety of environmental stressors which must be regulated and controlled to prevent degradation of the receiving water.

Table 4-1. Major Municipal Wastewater Treatment Plant Discharges with Permitted Monthly Average Flow Greater than 1 MGD in the Chattahoochee River Basin

NPDES Permit #	Facility Name	Authority	County	State	Receiving Stream	Permitted Monthly Average Flow (MGD)
HUC 03130001						
GA0046019	Cumming WPCP	Cumming	Forsyth	Georgia	Big Crk	2.000
GA0024333	Fulton Co. - Big Creek WPCP	Fulton Co.	Fulton	Georgia	Chattahoochee River	24.00
GA0030686	Fulton Co. -Johns Creek WPCP	Fulton Co.	Fulton	Georgia	Chattahoochee River	7.000
GA0023167	Buford Southside WPCP	Buford	Gwinnett	Georgia	Suwanee Cr	2.000
GA0026433	Gwinnett Co (Crooked Crk WPCP)	Gwinnett Co.	Gwinnett	Georgia	Chattahoochee River	36.00
GA0021504	Cornelia WPCP	Cornelia	Habersham	Georgia	So Fork-Little Mud Cr	3.000
GA0020168	Gainesville (WPCP No 2)	Gainesville	Hall	Georgia	Lake Lanier	3.000
GA0021156	Gainesville Flat Cr WPCP	Gainesville	Hall	Georgia	Flat Crk/Lake Lanier	7.000
HUC 03130002						
AL0024724	East Alabama WWTP	East Alabama	Chambers	Alabama	Chattahoochee River	4.000
AL0023159	Lanett WWTP	Lanett	Chambers	Alabama	Chattahoochee River	5.000
GA0026140	Cobb Co-Sutton WPCP	Cobb Co.	Cobb	Georgia	Chattahoochee River	40.00
GA0026158	Cobb Co.-So. Cobb WPCP	Cobb Co.	Cobb	Georgia	Chattahoochee River	28.00
GA0031721	Newnan Wahoo WPCP	Newnan	Coweta	Georgia	Unnamed Tributary to Wahoo Creek	2.300
GA0030341	Douglasville South WPCP	Douglasville	Douglas	Georgia	Anneewakee Crk Trib\Chattahoochee	3.250
GA0047201	Douglasville (Sweetwater)	Douglasville	Douglas	Georgia	Chattahoochee River	3.000
GA0021458	Atlanta- Utoy Creek WPCP	Atlanta	Fulton	Georgia	Chattahoochee River	40.00
GA0021482	Atlanta (R.M. Clayton WPCP)	Atlanta	Fulton	Georgia	Chattahoochee River	100.0
GA0024040	Atlanta (South River WPCP)	Atlanta	Fulton	Georgia	Chattahoochee River via Atlanta Utoy Creek	48.00
GA0025381	Fulton Co-Camp Creek WPCP	Atlanta	Fulton	Georgia	Chattahoochee River	13.00
GA0020052	West Point WPCP	West Point	Troup	Georgia	Chattahoochee River	1.000
GA0036951	LaGrange WPCP (Long Cane Crk)	Lagrange	Troup	Georgia	Chattahoochee River	12.5
HUC 03130003						
AL0061671	Eufaula WWTP	Eufaula	Barbour	Alabama	Chattahoochee River	2.700
AL0022209	Phenix City WWTP	Phenix City	Russell	Alabama	Chattahoochee River	7.750
GA0020516	Columbus - South WPCP	Columbus Water Works	Muscogee	Georgia	Chattahoochee River	40.00
HUC 03130004						
AL0022764	Dothan Omusee Creek WWTP	Dothan	Houston	Alabama	Omusee Creek	5.000



Base modified from U.S. Geological Survey digital files

Figure 4-1. Location of Municipal Wastewater Treatment Plants in the Chattahoochee River Basin

EPD NPDES permit program provides a basis for regulating municipal and industrial waste discharges, monitoring compliance with limitations, and appropriate enforcement action for violations. For point source discharges, the permit establishes specific effluent limitations and specifies compliance schedules that must be met by the discharger. Effluent limitations are designed to achieve water quality standards in the receiving water, and are re-evaluated periodically (at least every 5 years).

Municipal wastewater treatment plants are among the most significant point sources regulated under the NPDES program in the Chattahoochee River Basin, accounting for greater than 96% of the total point source effluent flow (exclusive of cooling water). These plants collect, treat, and release large volumes of treated wastewater. Pollutants associated with treated wastewater include pathogens, nutrients, oxygen demanding waste, metals, and chlorine residuals. Over the past several decades, Georgia has invested over $500,000,000 in construction and upgrade of municipal water pollution control plants in the Chattahoochee River Basin, as summarized in Appendix C. These upgrades have resulted in significant reductions in pollutant loading and consequent improvements in water quality below wastewater treatment plant outfalls. The most widely used measure of municipal pollution is the extent to which the organic content of treated wastewater depletes oxygen in the receiving water and reduces the oxygen available to fish and aquatic life. In 1994, it was estimated that approximately 93% of oxygen demanding wastes produced by municipalities was removed by municipal water pollution control plants. As of the 1994-95 water quality assessment, only 6 segments (60 miles) of river/streams were identified in which municipal discharges contributed to not fully supporting designated uses, all of which are being addressed through the NPDES permitting process. A current issue for Atlanta and Columbus is combined sewer overflows (CSOs) which have historically discharged diluted, untreated municipal wastewater during wet weather. Georgia is currently in the process of bringing all CSOs into compliance with federal and State water quality standards, as described in Section 4.1.1.2.

Most urban wastewater treatment plants also receive industrial process and non-process wastewater, which may contain a variety of conventional and toxic pollutants. Control of industrial pollutants in municipal wastewater is addressed through pretreatment programs. The major publicly-owned wastewater treatment plants in this basin have developed and implemented approved local industrial pretreatment programs. Through these programs, the wastewater treatment plants are required to establish effluent limitations for their significant industrial dischargers (those that discharge in excess of 25,000 gallons per day of process wastewater or are regulated by a Federal Categorical Standard) and to monitor the industrial user's compliance with those limits. The treatment plants are able to control the discharge of organics and metals into their sewerage system through the controls placed on their industrial users.

Industrial and federal wastewater discharges are also significant point sources regulated under the NPDES program. There are a total of 179 permitted municipal, state, federal, private, and industrial wastewater and process water discharges in the Chattahoochee River Basin, as summarized in Table 4-2. The complete permit list is summarized in Appendix D.

Only a small number of the industrial dischargers discharge significant amounts of flow. Since the nature of industrial discharges varies widely compared to discharges from municipal plants, effluent flow is not generally a good measure of the significance of an industrial discharge. Industrial discharges can consist of organic heavy oxygen-demanding waste loads

Table 4-2. Summary of NPDES Permits in the Chattahoochee River Basin

HUC	Major Municipal Facilities		Major Industrial and Federal Facilities		Small Public and Private and Minor Industrial Facilities		Total
	Georgia	Alabama	Georgia	Alabama	Georgia	Alabama	
03130001	8	-	1	-	60	-	69
03130002	11	2	3	0	58	4	78
03130003	1	2	1	1	7	12	24
03130004	0	1	1	1	2	3	8

from facilities such as pulp and paper mills, large quantities of non-contact cooling water and very little else from facilities such as power plants, pit pumpout and surface runoff from mining and quarrying operations where the principal source of pollutants is the land disturbing activity rather than the addition of any chemicals or organic materials, or complex mixtures of organic and inorganic pollutants from chemical manufacturing, textile processing, metal finishing, etc. Pathogens and chlorine residuals are rarely of concern with industrial discharges, but other conventional and toxic pollutants must be addressed on a case-by-case basis through the NPDES permitting process. As of the 1994-95 water quality assessment, six (6) segments (47 miles) of river/streams in the Georgia portion of the basin were identified in which industrial discharges contributed to not supporting designated uses, all of which are being addressed through the NPDES permitting process. Table 4-3 lists the eight major industrial and federal wastewater treatment plants with discharges into the Chattahoochee River Basin in Georgia and Alabama. There are also 59 minor industrial discharges which may have the potential to cause localized stream impacts, but are relatively insignificant from a basin perspective.

The locations of permitted point source discharges of treated wastewater in the Chattahoochee River Basin are shown in Figures 4-2 through 4-5 .

4.1.1.2 Combined Sewer Overflows

Combined sewers are sewers that carry both storm water runoff and sanitary sewage in the same pipe. Most of these combined sewers were built at the turn of the century and were found in most large cities. At that time both sewage and storm water runoff were piped from the buildings and streets to the small streams that originated in the heart of the city. When these streams were enclosed in pipes, they became today's combined sewer systems. As the cities grew, their combined sewer system expanded. Often new combined sewers were laid in order to move the untreated wastewater discharge to the outskirts of the town or to the nearest waterbody.

In later years wastewater treatment facilities were built and smaller sanitary sewers were constructed to carry the sewage (dry weather flows) from the termination of the combined sewers to these facilities for treatment. However during wet weather when significant stormwater is carried in the combined system, the sanitary sewer capacity is exceeded and a combined sewer overflow (CSO) occurs. The surface discharge is a mixture of stormwater and

Table 4-3. Major Industrial and Federal Wastewater Treatment Facilities in the Chattahoochee River Basin

NPDES Permit #	Facility Name	Description	County	Receiving Stream
HUC 03130001				
GA0001112	Scovill Fasteners	Manufacturing - Fasteners	Habersham (Georgia)	Soque River
HUC 03130002				
GA0000922	Franklin Aluminum Co.	Manufacturing - Nonferrous Metals	Heard (Georgia)	Hillabahatchee Creek
GA0001473	GA. Power - Plant Yates	Electric Power	Coweta (Georgia)	Chattahoochee River
GA0001198	USAF Lockheed - Martin Plant #6	National Security	Cobb (Georgia)	Nickajack Creek, Rottenwood Creek, Poorhouse Creek
HUC 03130003				
AL0000817	Mead Coated Board	Manufacturing - Paperboard	Russell (Alabama)	Chattahoochee River
GA0000973	U.S. Army - Fort Benning	National Security	Chattahoochee (Georgia)	Chattahoochee River
HUC 03130004				
AL0024619	SNC Farley Nuclear Plant	Electric Power	Houston (Alabama)	Chattahoochee River
GA0001201	Ga. Pacific Corp.	Paper	Early (Georgia)	Chattahoochee River

sanitary waste. Uncontrolled CSOs thus discharge raw diluted sewage, and can introduce elevated concentrations of bacteria, BOD, and solids into a receiving water body. In some cases, CSOs discharge into relatively small creeks.

CSOs are considered a point source of pollution and are subject to the requirements of the Clean Water Act. Although CSOs are not required to meet secondary treatment effluent limits, sufficient controls are required to protect water quality standards for the designated use of the receiving stream. In the 1990 session of the Georgia Legislature, a CSO law was passed requiring all Georgia cities to eliminate or treat CSOs. There are two cities in the Chattahoochee River Basin that have combined sewer systems, Atlanta and Columbus.

Although CSO controls are well underway in the Chattahoochee Basin, there are very limited data on the overall effectiveness of the controls and resulting improvement to water quality. The next Basin Planning cycle should provide more information on the effects of CSO mitigation on water quality in the Chattahoochee Basin.

Atlanta CSOs

The City of Atlanta began studying their CSOs in the early 1970's and some crude screening and grit removal facilities were installed. Following the 1990 legislative action, the City developed a control plan that involved two different types of control methods: direct treatment

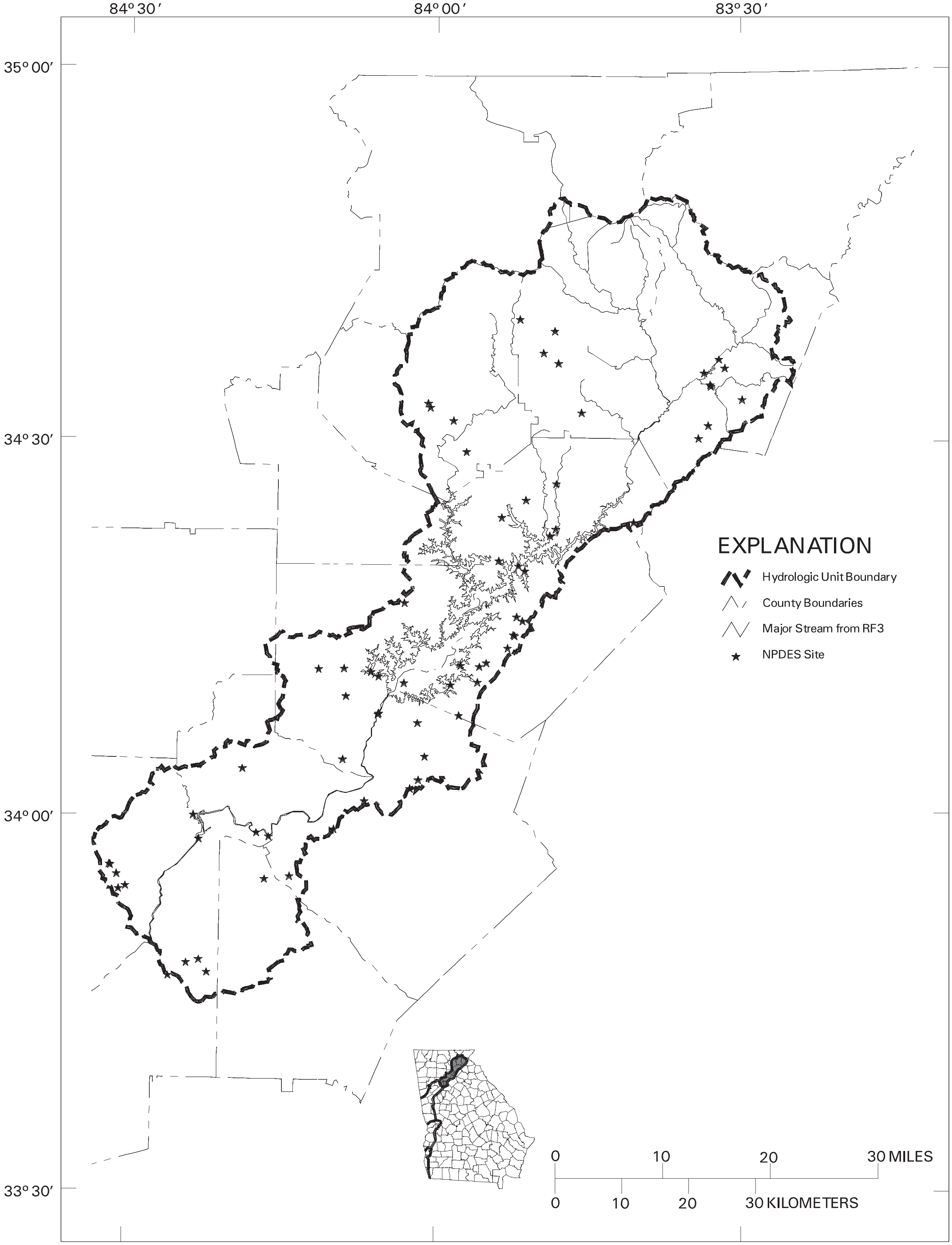


Figure 4-2. NPDES Sites Permitted by GAEPD, Upper Chattahoochee River Basin, HUC 03130001

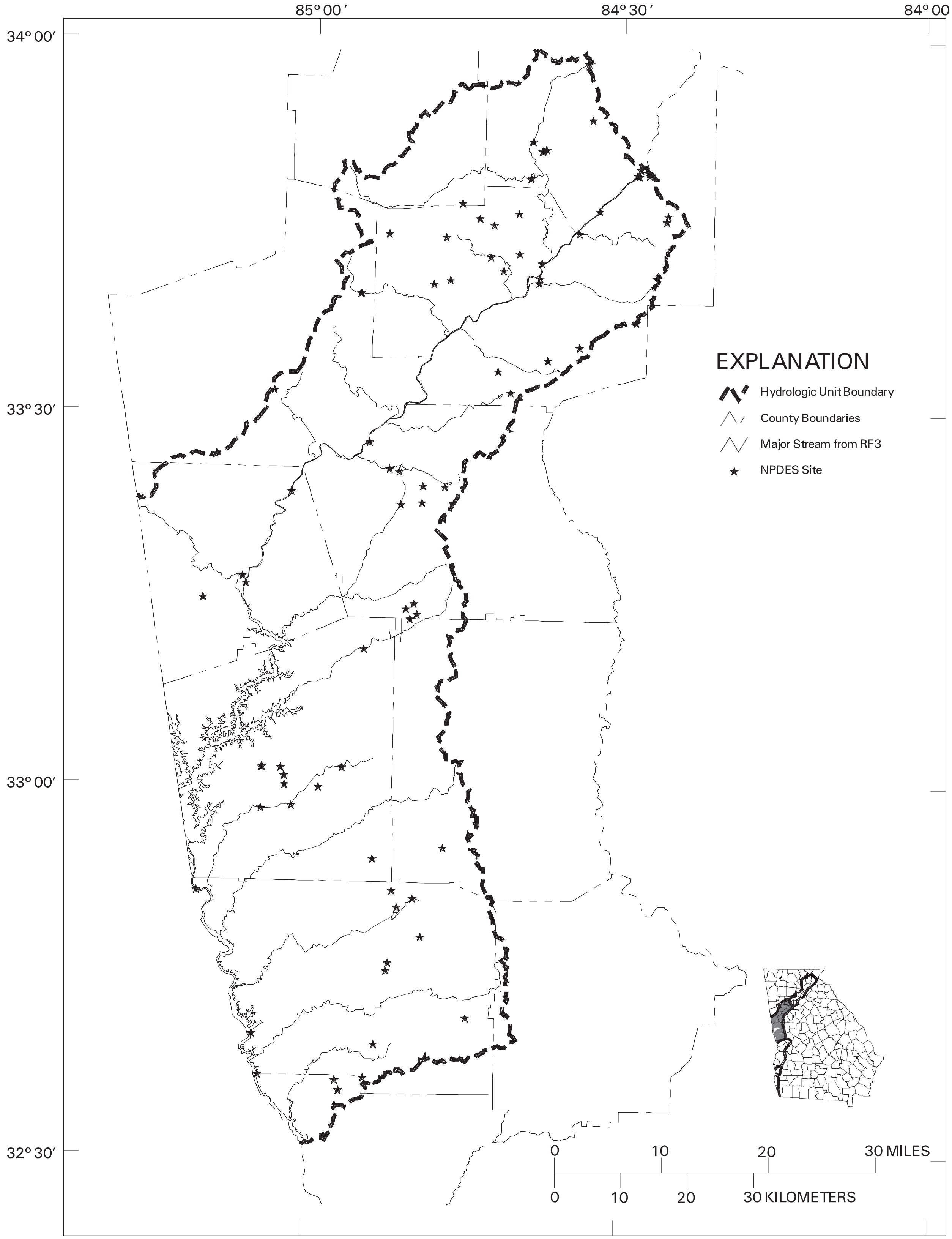


Figure 4-3. NPDES Sites Permitted by GAEPD, Middle Chattahoochee River Basin, HUC 03130002

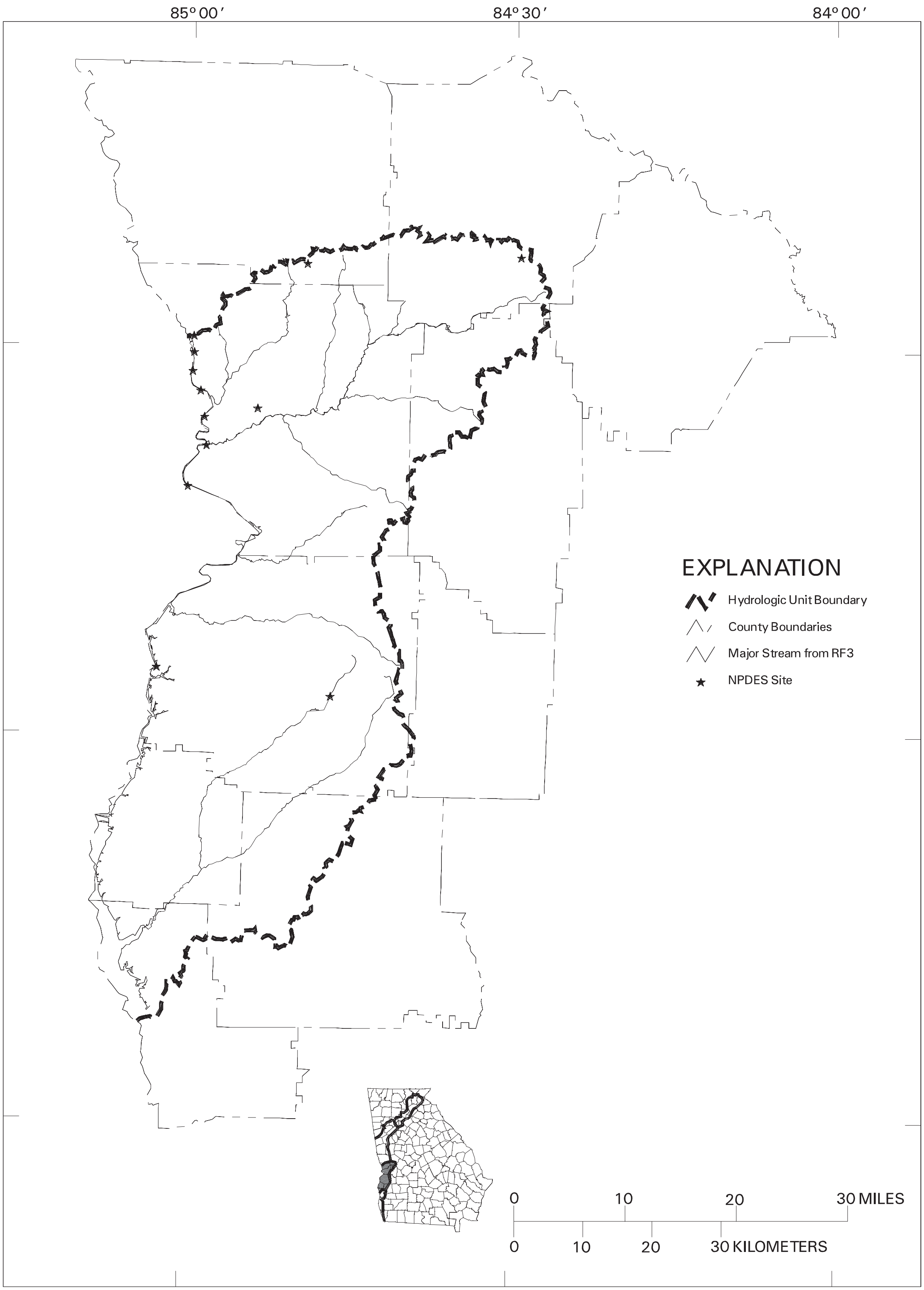


Figure 4-4. NPDES Sites Permitted by GAEPD, Middle Chattahoochee River Basin, HUC 03130003

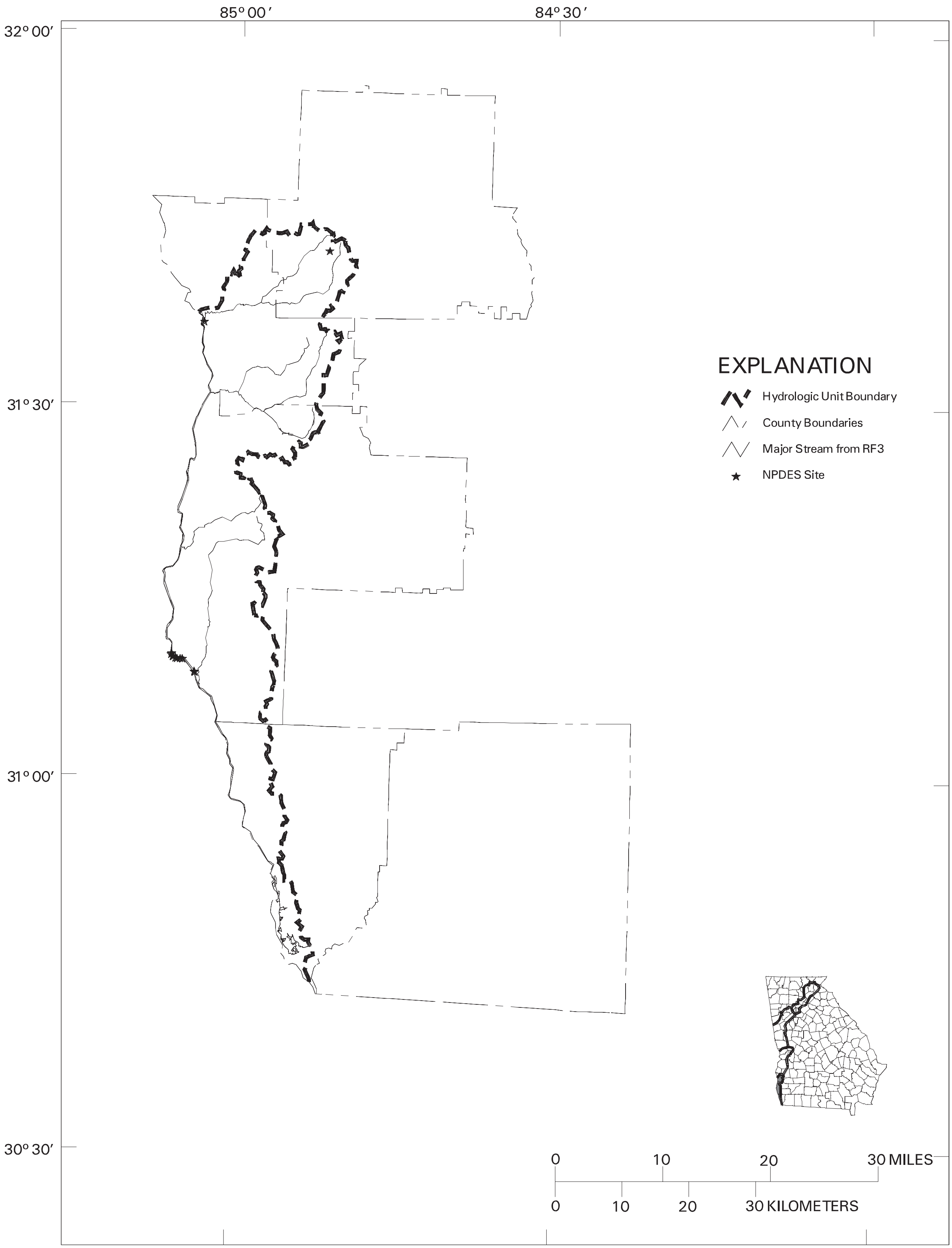


Figure 4-5. NPDES Sites Permitted by GAEPD, Lower Chattahoochee River Basin, HUC 03130004

with screening / disinfection and sewer separation. There are six CSOs in Atlanta that discharge or formerly discharged to the Chattahoochee basin (Table 4-4).

The Tanyard Creek, North Avenue and Greensferry facilities, consisting of coarse and fine screens and disinfection, became operational in 1994. These treatment facilities were designed to remove debris by screening. In addition, all of the overflow is chlorinated to kill bacteria. The total cost of CSO controls on these three facilities was approximately $40 million. These controls significantly reduce the impact of CSO events on the Chattahoochee.

The Clear Creek CSO treatment facility (HUC 03130001), with screening and disinfection similar to the three that are in operation, was constructed in Piedmont Park to treat combined sewer overflows from that area. The work was complete in late 1997. Projected total cost for the Clear Creek project is approximately $80 million.

There is one major CSO in the Basin that does not yet have controls in operation and continues to discharge untreated waste during wet weather:

- The City is utilizing sewer separation in the Utoy Creek basin (HUC 03130002). Construction on the sewer separation project began in early 1996. The project is expected to be completed by the end of 1998. Utoy Creek sewer separation construction cost will not be known until the design work is finalized. Current estimated cost is around $50 million.

Columbus CSOs

The City of Columbus owns and operates a wastewater collection system and treatment facility for the City and Muscogee County. Approximately 10% of the sewer system service area contains combined sewers (about 2600 acres). An additional 2600 acres of separate sanitary sewers discharge into the combined sewer systems. There were 16 CSO discharge points prior to control; 15 flowing directly to the Chattahoochee River and one to Weracoba Creek, a tributary (all within HUC 03130003). Approximately 18% of the annual CSO volume is intercepted and transported to the South Columbus Wastewater Treatment facility.

Table 4-4. Status of Atlanta Combined Sewer Overflows

CSO NAME	CONTROL METHOD	STATUS	NPDES Permit
HUC 03130001			
Tanyard Creek	Screening and Disinfection	In Operation	GA0037109
Clear Creek	Screening and Disinfection	Under Construction	GA0036871
Glidden (Woodall Creek)	Sewer Separation	Eliminated	No longer discharges
HUC 03130002			
Utoy Creek (West End Park, Cascade Road)	Sewer Separation	Under Construction	GA0037095
North Avenue (Proctor Creek)	Screening and Disinfection	In Operation	GA0037117
Greensferry (Proctor Creek)	Screening and Disinfection	In Operation	GA0037125

Following the action by the Georgia Legislature in 1990, Columbus initiated studies to examine the pollution impact of its CSOs. Collection systems were modeled and a variety of alternative controls were evaluated. Direct treatment of the CSO was determined to be the most cost-effective control technology.

At present, Columbus CSOs include two treatment systems, Northern and Southern. Both include a combination of sewer separation, flow diversion and control, gravity and force main transport and direct treatment at the only two remaining overflow locations, 19th Street and State Docks. These two treatment facilities consist of vortex separators for solids removal followed by chemical disinfection. The total cost of the Columbus CSO project was approximately $80 million and the project was operational by December, 1995. Combination of treatment and solids removal should substantially reduce loads of pollutants derived from the system.

4.1.1.3 NPDES Permitted Stormwater Discharges

Urban stormwater runoff has been identified as a major source of stressors such as oxygen demanding waste (BOD) and fecal coliform bacteria in the Chattahoochee basin. Stormwater may flow directly to streams as a diffuse, nonpoint process, or may be collected and discharged through a storm sewer system. Storm sewers are now subject to NPDES permitting and are discussed in this section. Nonpoint stormwater is discussed in Section 4.1.2.2.

Pollutants typically found in urban storm water runoff include pathogens (such as bacteria and viruses from human and animal waste), heavy metals, debris, oil and grease, petroleum hydrocarbons and a variety of compounds toxic to aquatic life. In addition, the runoff often contains sediment, excess organic material, fertilizers (particularly nitrogen and phosphorus compounds), herbicides, and pesticides which can upset the natural balance of aquatic life in lakes and streams. Storm water runoff may also increase the temperature of a receiving stream during warm weather, which is particularly threatening to the valuable trout fishery in the Chattahoochee River Basin. All of these pollutants, and many others, influence the quality of storm water runoff. There are also many potential problems related to the quantity of urban runoff, which can contribute to flooding and erosion in the immediate drainage area and downstream.

In accordance with Federal "Phase I" storm water regulations, the State of Georgia has issued individual area-wide NPDES municipal separate storm sewer system (MS4) permits to 58 cities and counties in municipal areas with populations greater than 100,000 persons. Permits in the Chattahoochee basin are shown in Table 4-5.

Industrial sites often have their own stormwater conveyance systems. Volume and quality of storm water discharges associated with industrial activity is dependent upon a number of different factors, such as the industrial activities occurring at the facility, the nature of precipitation, and the degree of surface imperviousness. These discharges are of intermittent duration with short-term pollutant loadings that can be high enough to have shock loading effects on the receiving waters. The types of pollutants from industrial facilities are generally similar to those found in storm water discharges from commercial and residential sites; however, industrial facilities have a significant potential for discharging at higher pollutant concentrations, and may include specific types of pollutants associated with a given industrial activity.

Table 4-5. Permitted Municipal Separate Storm Sewer Systems, Chattahoochee River Basin

Permit #	Permittee	Contact	Address	City	ZIP	County	Type	Issued	Expires	HUC
GAS000105	Chamblee	Mr. Johnson W. Brown, Mayor	5468 Peachtree Road	Chamblee	30341	DeKalb	Large/DeKalb Coapp	06/15/94	06/14/99	03130001
GAS000113	Doraville	Gene Lively, Mayor	3725 Park Avenue	Doraville	30340	DeKalb	Large/DeKalb Coapp	06/15/94	06/14/99	03130001
GAS000131	Roswell	Scott Forward, Eng. Division	38 Hill Street, Suite C-50	Roswell	30075	Fulton	Large/Independent	06/15/94	06/14/99	03130001
GAS000102	Alpharetta	Mr. Jarvis Middleton, P.W. Dept.	82 Haynes Bridge Road	Alpharetta	30201	Fulton	Large/Independent	06/15/94	06/14/99	03130001
GAS000135	Sugar Hill	Gary Wilson, Mayor	4988 West Broad Street	Sugar Hill	30518	Gwinnett	Large/Gwinnett Coapp	06/15/94	06/14/99	03130001
GAS000144	Suwanee	Richard A. Trice, Mayor	Post Office Box 58	Suwannee	30174	Gwinnett	Large/Gwinnett Coapp	06/15/94	06/14/99	03130001
GAS000127	Norcross	Lillian Webb, Mayor	65 Lawrenceville Street	Norcross	30071	Gwinnett	Large/Gwinnett Coapp	06/15/94	06/14/99	03130001
GAS000112	Duluth	Shirley Lassiter, Mayor	3578 West Lawrenceville Street	Duluth	30136	Gwinnett	Large/Gwinnett Coapp	06/15/94	06/14/99	03130001
GAS000138	Berkeley Lake	Mr. Richard Schmidt, Mayor	4040 Berkeley Lake Road	Berkeley Lake	30136	Gwinnett	Large/Gwinnett Coapp	06/15/94	06/14/99	03130001
GAS000104	Buford	Mr. Mitch Peavey, City Mgr	95 Scott Street	Buford	30518	Gwinnett	Large/Gwinnett Coapp	06/15/94	06/14/99	03130001
GAS000108	Cobb County	Henry Mingledorff, C.C.Water Sys.	680 South Cobb Drive, Bldg 3	Marietta	30060	Cobb	Large/Independent	06/15/94	06/14/99	001&002
GAS000125	Marietta	Russell Moorehead, PW Dept	205 Lawrence Street	Marietta	30060	Cobb	Large/Independent	06/15/94	06/14/99	001&002
GAS000132	Smyrna	Ken Hildebrandt, PW Dept.	Post Office Box 1226	Smyrna	30081	Cobb	Large/Independent	06/15/94	06/14/99	001&002
GAS000117	Fulton County	Earl Burrell, PW Dept	141 Pryor Street, SW, Suite 6001	Atlanta	30303	Fulton	Large/Independent	06/15/94	06/14/99	001&002
GAS000100	Atlanta	Mr. Richard Chime, P.W. Dept.	55 Trinity Avenue, Suite 4700	Atlanta	30335	Fulton	Large/Independent	06/15/94	06/14/99	001&002
GAS000103	Austell	Mr. Clay Hays,P.W. Director	2716 Broad Street	Austell	30001	Cobb	Large/Independent	06/15/94	06/15/99	03130002
GAS000129	Powder Springs	Bobby Elliot, PW Dept	Post Office Box 46	Powder Springs	30073	Cobb	Large/Independent	06/15/94	06/14/99	03130002
GAS000128	Palmetto	William Gaddy, PW Dept.	Post Office Box 190	Palmetto	30268	Fulton	Large/Independent	06/15/94	06/14/99	03130002
GAS000115	Fairburn	Tony Cox, City Admin.	Post Office Box 145	Fairburn	30213	Fulton	Large/Independent	06/15/94	06/14/99	03130002
GAS000114	East Point	Derek Bogan, PW Dept	2777 East Point Street	East Point	30344	Fulton	Large/Independent	06/15/94	06/14/99	03130002
GAS000109	College Park	Brad Russell, WQ Coord.	1886 West Harvard Avenue	College Park	30337	Fulton	Large/Independent	06/15/94	06/14/99	03130002
GAS000136	Union City	Sonya Carter, City Admin.	5047 Union Street	Union City	30291	Fulton	Large/Independent	06/15/94	06/14/99	03130002
GAS000202	Columbus Consolidated Govt.	Ron Smith, Eng.	Post Office Box 1340	Columbus	31993	Muscogee	Medium/Independent	04/20/95	04/19/00	03130003

EPD has issued one general permit regulating storm water discharges for 10 of 11 Federally regulated industrial subcategories. The eleventh subcategory, construction activities, will be covered under a separate general permit. The general permit for industrial activities requires the submission a Notice of Intent (NOI) for coverage under the general permit, the preparation and implementation of a storm water pollution prevention plan, and in some cases, the monitoring of storm water discharges from the facility. As with the municipal storm water permits, implementation of site-specific best management practices is the preferred method for controlling storm water runoff. As of December 31, 1995 approximately 2600 "Notice of Intent" applications for these general permits have been submitted to EPD. It is estimated that greater than 10,000 facilities may ultimately be impacted by the stormwater regulations.

4.1.1.4 Non-discharging Waste Disposal Facilities

Land Application Systems (LAS)

In addition to permits for point source discharges, EPD has developed and implemented a permit system for land application systems. Land application systems for final disposal of treated wastewaters have been encouraged in Georgia, and are designed to eliminate surface discharges of effluent to waterbodies. Land application systems are used as alternatives to advanced levels of treatment or as the only alternative in some environmentally sensitive areas.

When properly operated, a LAS should not be a source of stressors to surface waters. Their locations are, however, worth noting because of the (small) possibility that a LAS could malfunction and become a source of stressor loading.

A total of 128 municipal and 35 industrial permits for land application systems were in effect in Georgia in 1995. Municipal and other major wastewater land application systems (permitted flow greater than 0.01 MGD) within the Chattahoochee Basin are listed in Table 4-6. The locations of all LAS's within the basin are shown in Figures 4-6 through 4-9.

Landfills

Permitted landfills are required to contain and treat any leachate or contaminated run-off prior to discharge to any surface water. The permitting process encourages either direct connection to a publicly-owned treatment works (although vehicular transportation is allowed in certain cases) or treatment and recirculation on-site to achieve a no-discharge system. Direct discharge in compliance with NPDES requirements is allowed but not currently practiced at any landfills in Georgia. Groundwater contaminated by landfill leachate from older, unlined landfills represents a potential threat to waters of the State. Groundwater and surface water monitoring and corrective action requirements are in place for all landfills operated after 1988 to identify and remediate potential threats. Provisions of the Hazardous Sites Response Act address threats posed by older landfills as releases of hazardous constituents are identified. All new municipal solid waste landfills are required to be lined and have a leachate collection system installed.

EPD's Land Protection Branch is responsible for permitting and compliance of municipal and industrial Subtitle D landfills. The location of permitted landfills within the basin is shown in Figures 4-10 through 4-13.

Table 4-6. Wastewater Land Application Systems in the Chattahoochee Basin

Operator	Location	Permit No.	Permitted Flow (MGD)
Municipal/Privately Owned Treatment Systems			
Alexander High School	Douglas Co.	GA03-757	0.038
Chattahoochee Co.	Chattahoochee Co.	GA02-224	0.022
Days Inn LaGrange	LaGrange	GA02-276	0.137
Dorsett Shoals Elementary School	Douglas Co.	GA03-826	0.011
Helen LAS	Helen	GA02-157	0.500
Inner Harbor Hospital	Paulding Co.	GA02-104	0.020
Sugar Hills LAS	Gwinnett Co.	GA02-0003	0.500
Unicoi	White Co.	GA02-066	0.075
U.S. Army Camp Merrill	Lumpkin Co.	GA03-727	0.350
Whitesburg LAS	Carroll Co.	GA02-118	0.080
Industrial and Agricultural Systems			
Crystal Farms	Hall Co.	GA01-527	0.015
Dutch Quality House	Hall Co.	GA01-432	0.040
Georgia Proteins, Inc.	Forsyth Co.	GA01-572	0.500
Glidden Company	Hall Co.	GA01-362	0.020
LJS Grease & Tallow	Carroll Co.	GA01-591	0.020
J.R. Wrigley Company	Hall Co.	GA01-595	0.050

4.1.2 Nonpoint Sources

The pollution impact on Georgia's streams has radically shifted over the last two decades. Streams are no longer dominated by untreated or partially treated sewage discharges which resulted in little or no oxygen and little or no aquatic life. The sewage is now treated, oxygen levels have recovered, and healthy fisheries have followed. Industrial discharges have also been placed under strict regulation. However, other sources of pollution are still affecting Georgia's streams. These sources are referred to as *nonpoint*, and consist of mud, litter, bacteria, pesticides, fertilizers, metals, oils, grease, and a variety of other pollutants which are washed from rural and urban lands by stormwater.

Nonpoint pollutant loading comprises a wide variety of sources not subject to point source control via NPDES permits. The most significant nonpoint sources are those associated with precipitation, washoff, and erosion, which may move pollutants from the land surface to water bodies. Both rural and urban land uses can contribute significant amounts of nonpoint pollution. A review of 1994-95 water quality assessment results for the Chattahoochee indicates that urban runoff and rural nonpoint sources contribute significantly to nonsupport of water uses.

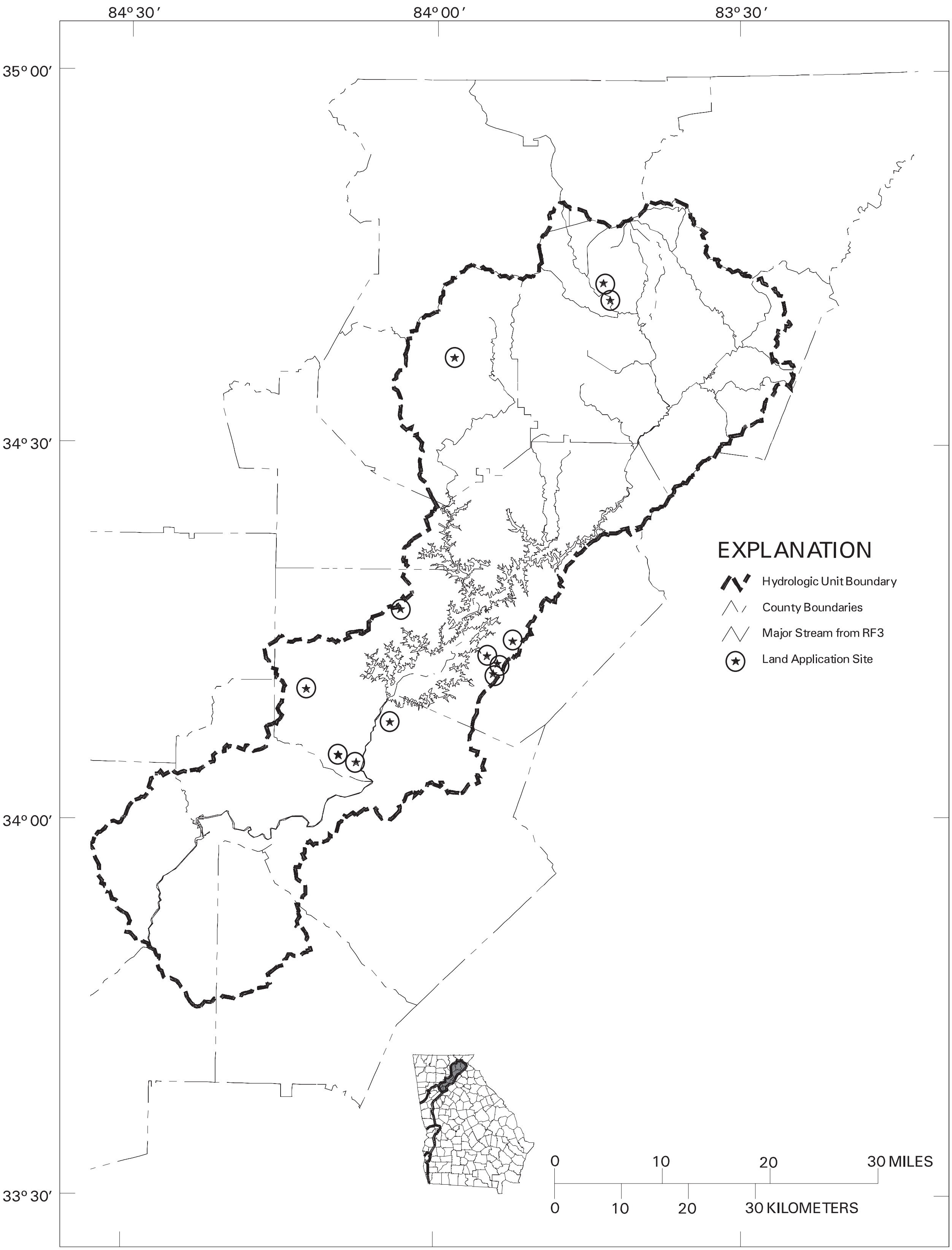


Figure 4-6. Land Application Systems, Upper Chattahoochee River Basin, HUC 03130001

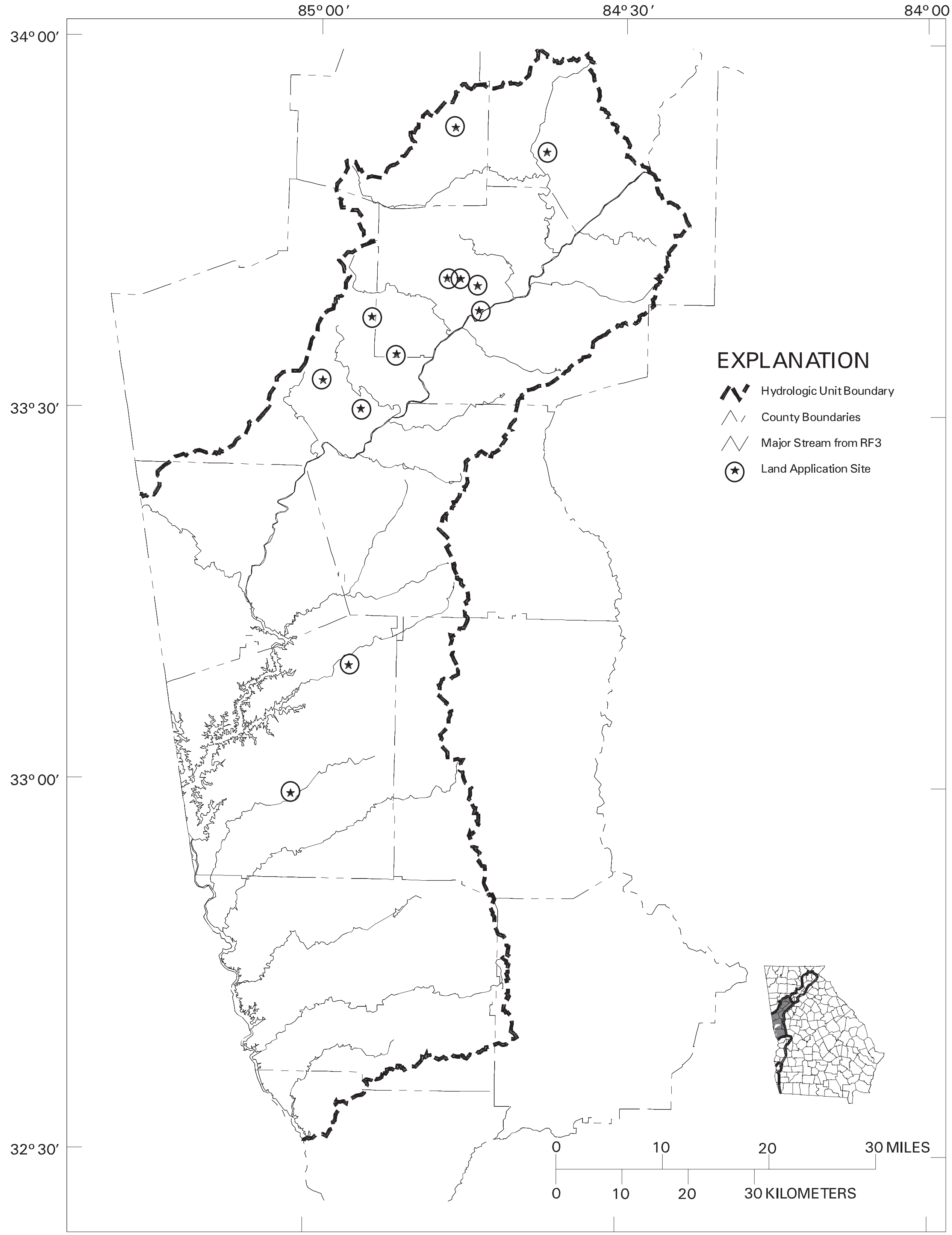


Figure 4-7. Land Application Systems, Middle Chattahoochee River Basin, HUC 03130002

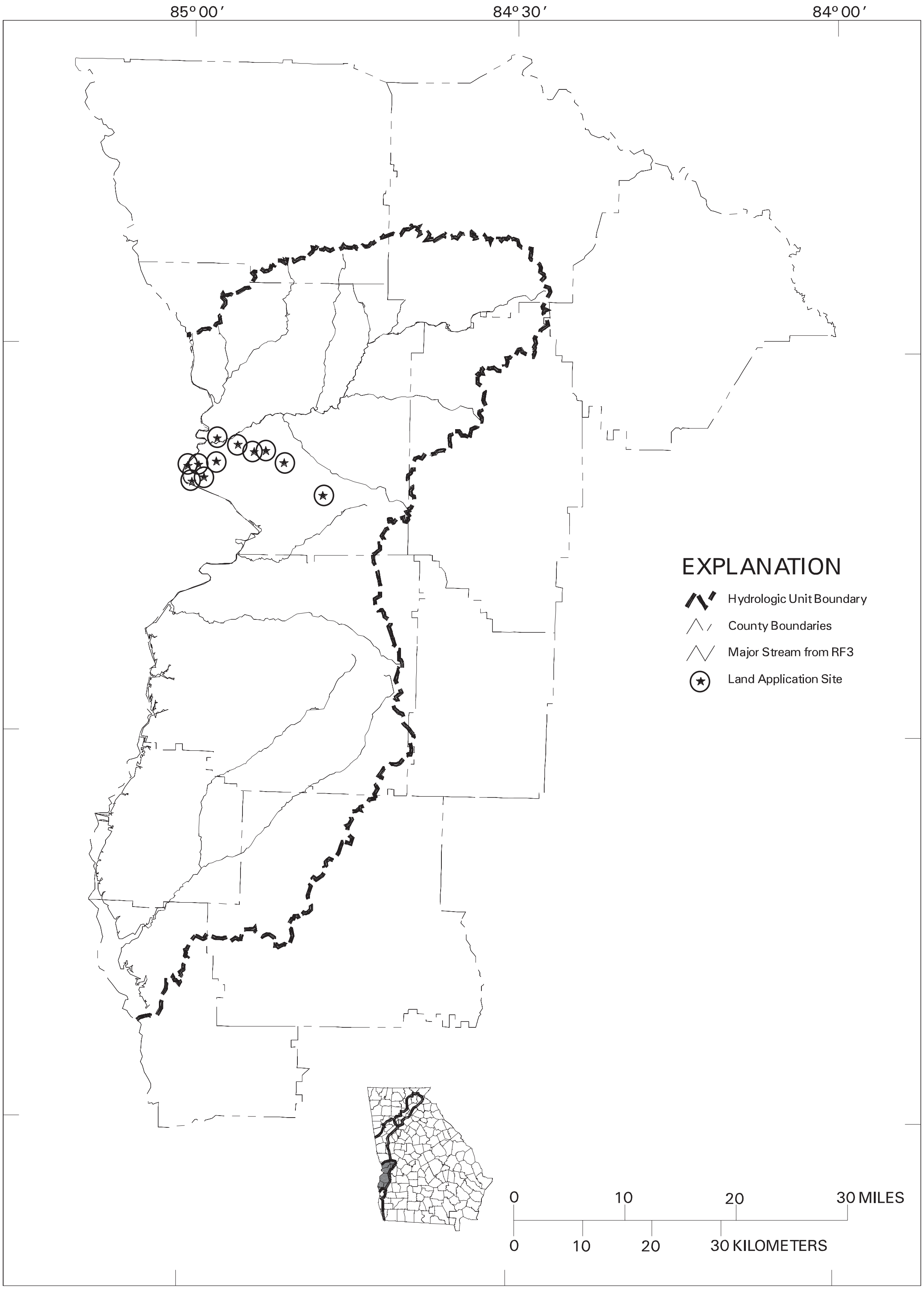


Figure 4-8. Land Application Systems, Middle Chattahoochee River Basin, HUC 03130003

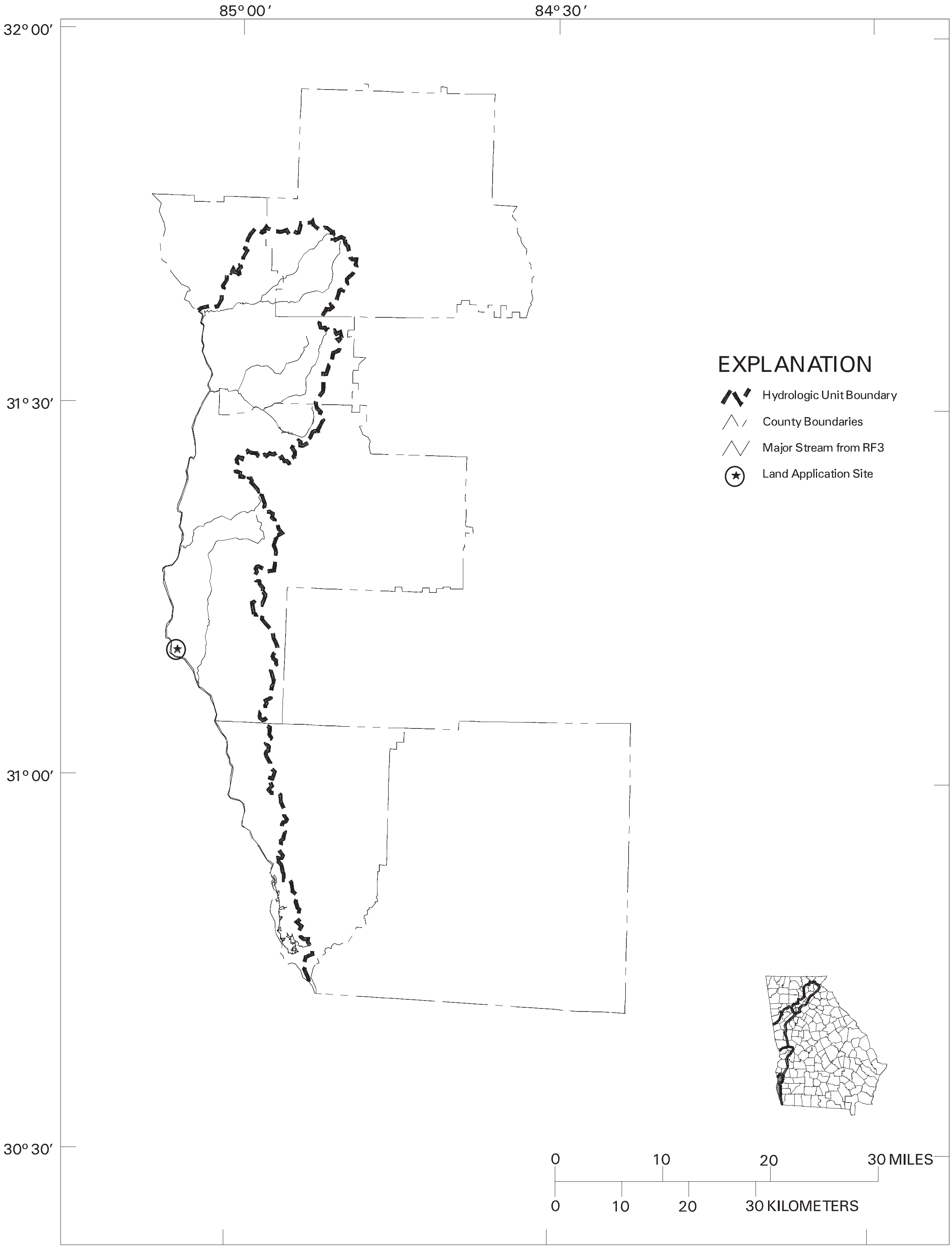


Figure 4-9. Land Application Sites, Lower Chattahoochee River Basin, HUC 03130004

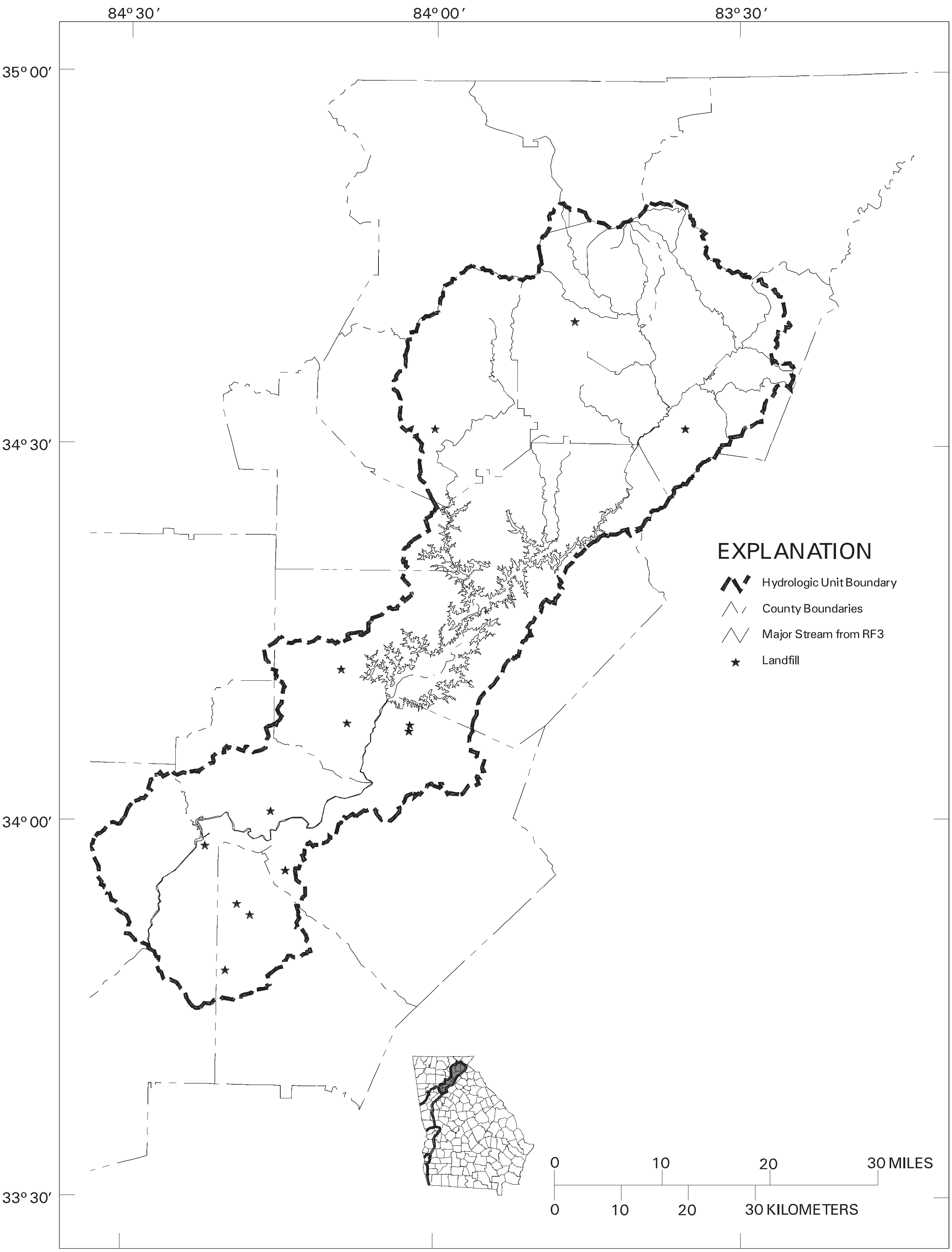


Figure 4-10. Landfills, Upper Chattahoochee River Basin, HUC 03130001

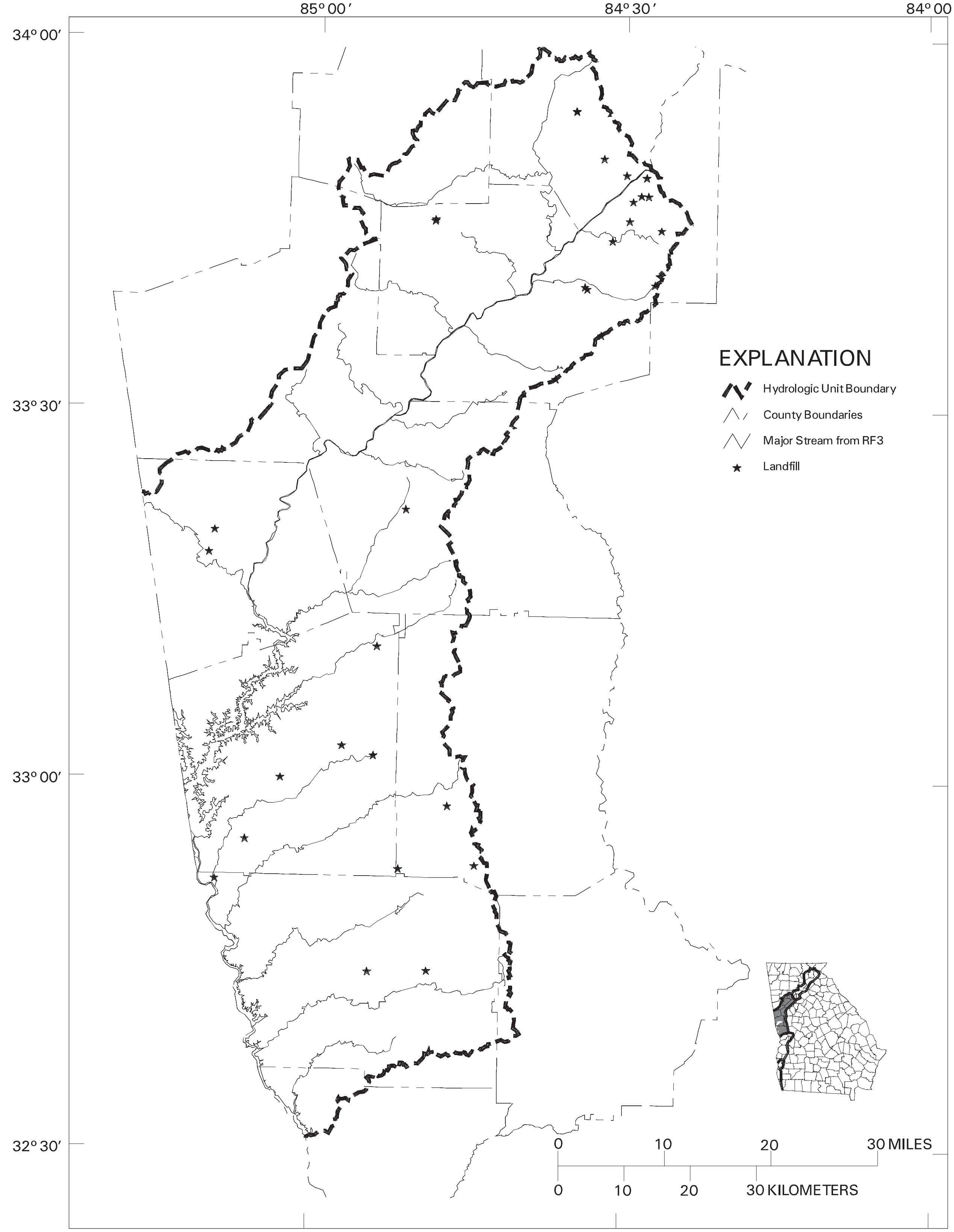


Figure 4-11. Landfills, Middle Chattahoochee River Basin, HUC 03130002

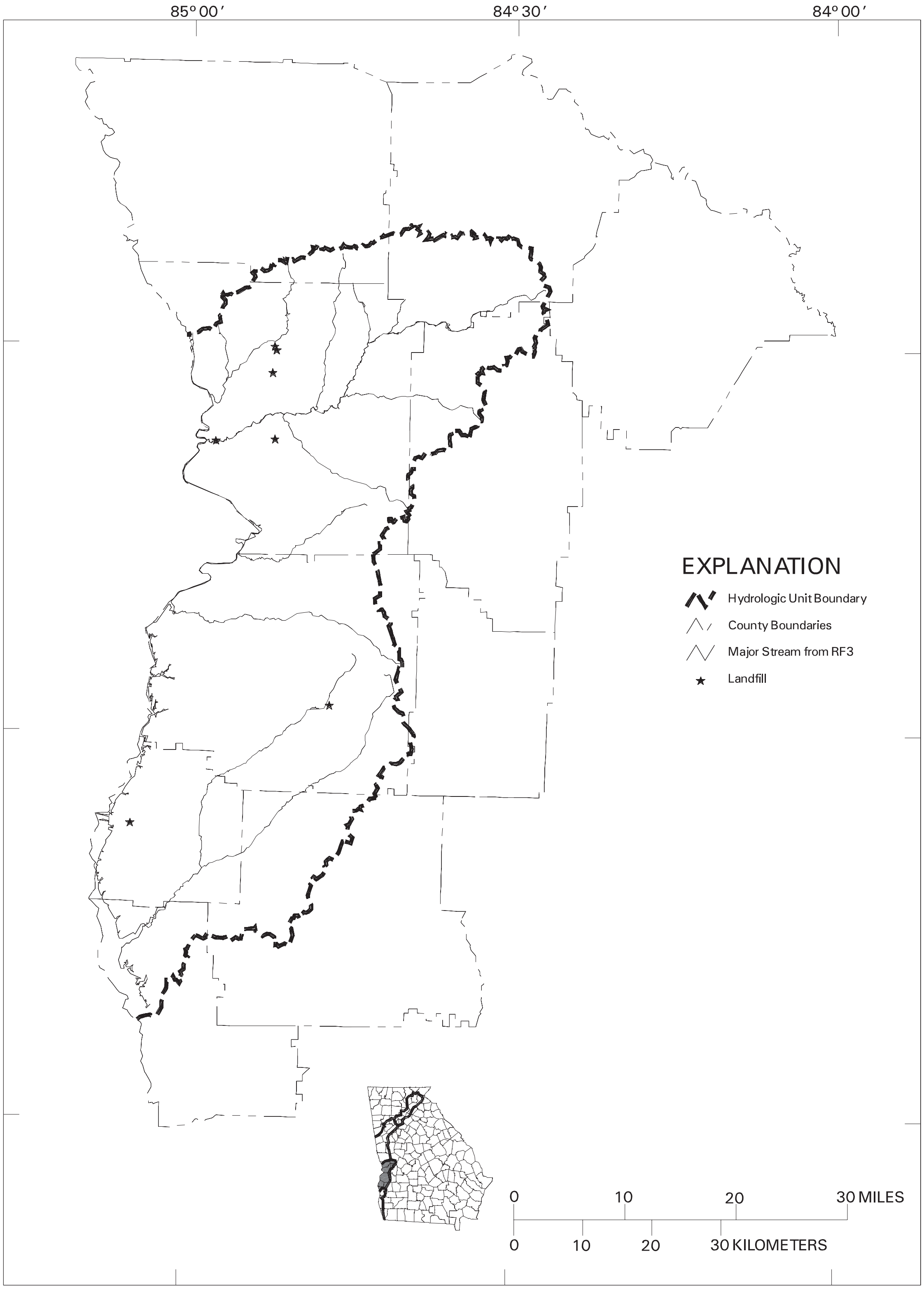


Figure 4-12. Landfills, Middle Chattahoochee River Basin, HUC 03130003

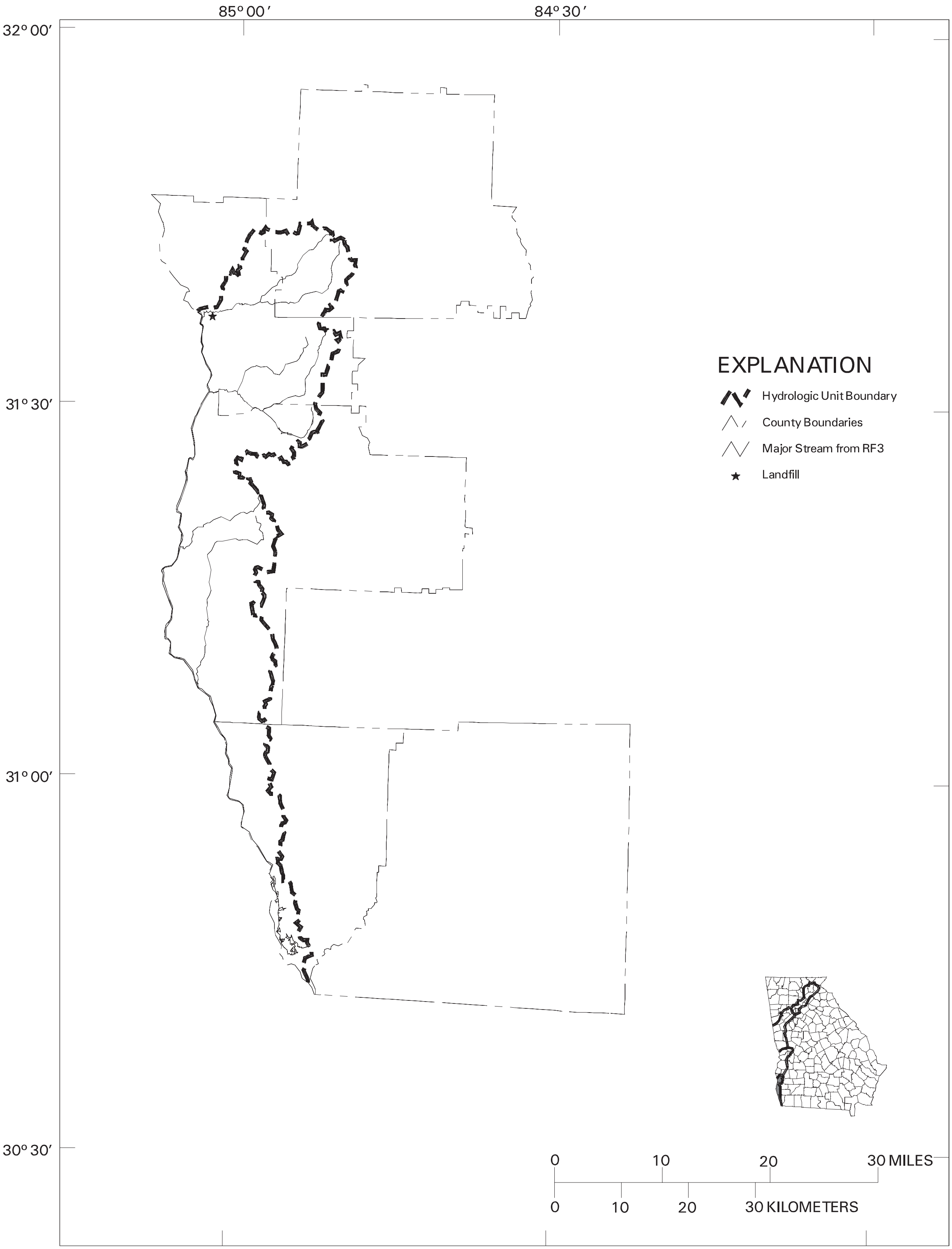


Figure 4-13. Landfills, Lower Chattahoochee River Basin, HUC 03130004

4.1.2.1 Nonpoint Sources from Agriculture

Agricultural operations can contribute stressors to water bodies in a variety of ways. Tillage and other soil disturbing activities may promote erosion and loading of sediment to water bodies, unless controlled by management practices. Nutrients contained in fertilizers, animal wastes, or natural soils may be transported from agricultural land to streams in either sediment-attached or dissolved forms. Loading of pesticides and pathogens is also of concern for various agricultural operations.

Sediment and Nutrients

Sediment is the most common pollutant resulting from agricultural operations. It consists mainly of mineral fragments resulting from the erosion of soils, but may also include crop debris and animal wastes. Excess sediment loads can damage aquatic habitat by smothering and shading food organisms, altering natural substrate, and destroying fish spawning areas. Runoff with elevated sediment concentrations can also scour aquatic habitat causing significant impacts to the biological community. Excess sediment may also increase water treatment costs, interfere with recreational uses of water bodies, create navigation problems, and increase flooding damage. In addition, a high percentage of nutrients lost from agricultural lands, particularly phosphorus, is transported attached to sediment. Many organic chemicals used as pesticides or herbicides are also transported predominantly attached to sediment.

Agriculture can be a significant source of nutrients, which can lead to excess or nuisance growth of aquatic plants and depletion of dissolved oxygen. The nutrients of most concern from agricultural land uses are nitrogen (N) and phosphorus (P), which may derive from commercial fertilizer or land application of animal wastes. Both nutrients assume a variety of chemical forms, including soluble ionic forms (nitrate and phosphate) and less soluble organic forms. Less soluble forms tend to travel with sediment, while more soluble forms move with water. Nitrate-nitrogen is very weakly adsorbed by soil and sediment, and is therefore transported entirely in water. Because of its mobility, the major route of nitrate loss is to streams by interflow or to groundwater in deep seepage.

Phosphorus transport is a complex process involving different components of phosphorus. Soil and sediment contain a pool of adsorbed phosphorus which tends to be in equilibrium with the phosphorus in solution (phosphate) as water flows over the soil surface. The concentrations established in solution are determined by soil properties and fertility status. Adsorbed phosphorus attached to soil particles suspended in runoff also equilibrates with the phosphorus in solution.

In 1993, the Soil Conservation Service (SCS, now NRCS) completed a study to identify hydrologic units in Georgia with high potential for nonpoint source (NPS) pollution problems resulting from agricultural land uses (SCS, 1993). This study concluded that there is not a major statewide agricultural pollution problem in Georgia. However, the assessment shows that some watersheds have sufficient agricultural loadings to potentially impair their designated uses, based on estimates of transported sediments, nutrients, and animal waste from agricultural lands.

In the SCS study, estimates of potential agricultural NPS loads were based on county units. An erosion index was developed for each county that included soil erodibility, slope, and slope length. Each county was assigned to one of seven Major Land Resource Areas on which a joint

Agricultural Research Service (ARS) and EPA study (USDA Utilization Research Report No. 6 and EPA-600/2-79-059) gave estimates of annual runoff, pounds per acre of dissolved nitrogen and phosphorus from applied animal waste, and a method of converting pound per acre to parts per million (ppm) concentration in runoff from agricultural lands.

Data on agricultural lands, land use, and animal units were developed for each county and reviewed and modified by the local agricultural Field Advisory Committee. Erosion and sediment yield data bases were calculated and compiled for agricultural lands based on county erosion indexes and cover factors. Nutrient needs were also developed by county and watershed. Potential nutrient loads were based on a worst case scenario where nutrients needed for agricultural lands are provided entirely from commercial fertilizer and animal waste is not managed for its nutrient value. Erosion and sediment yields were developed based on county cropland and grassland data. Estimates include sheet, rill, and ephemeral gully erosion, factored by a delivery ratio to the streams.

Estimates of sediment, nitrogen and phosphorus loads from agricultural lands were calculated by SCS (1993) on a county basis, then converted to average concentrations per event. These loads represent movement from agricultural fields, not delivery to waters, which will be less. Reporting on a concentration basis helps account for the fact that county boundaries generally do not coincide with watershed boundaries. Estimates for agricultural loading for those counties with significant land area within the Chattahoochee River Basin are summarized in Table 4-7.

Based on these analyses, SCS (1993) and the Georgia Soil and Water Conservation Commission (GSWCC) also identified specific watersheds within the Chattahoochee River Basin which have potential water quality problems associated with agricultural runoff. The identification was updated by the GSWCC for inclusion in Georgia's 1995 305(b) report and is shown in Table 4-8. The list represented the best effort by the Federal and State agricultural agencies to identify potential water problem areas, but was not based on documented water quality problems. Mileages presented are based on taking a flat percentage of stream miles within the hydrologic unit and represent an estimate only.

In July and August of 1996, EPD conducted additional biological assessment of the waters listed in Table 4-8 to determine which of these waters should be added to Georgia's Section 303(d) list of water quality limited segments. Those waters designated with a "3" under 303(d) Priority Ranking were added to the § 303(d) list in December 1996. Those designated with a "0" were determined not to be water quality limited segments based on the July-August 1996 sampling.

Animal waste

Besides contributing to nutrient loads, animal waste may contribute high loads of oxygen demanding chemicals and bacterial and microbial pathogens. The waste may reach surface waters through direct runoff as solids or in their soluble form. Soluble forms may reach groundwater through runoff, seepage, or percolation and surface water as return flow. The organic materials place an oxygen demand on the receiving waters during their decomposition

Table 4-7. Estimated Loads from Agricultural Lands by County (SCS, 1993)

County	Acres with nutrient application	Sediment (tons)	Sediment (ppm)	Nitrogen (tons)	Nitrogen (ppm)	Phosphorus (tons)	Phosphorus (ppm)
Hydrologic Unit 03130001, Upper Chattahoochee River							
DeKalb	990	199	6.6	2	0.07	1	0.022
Forsyth	36057	27381	26.6	330	0.32	69	0.067
Gwinnett	16491	2761	5.9	75	0.16	18	0.038
Habersham	36763	57644	54.8	489	0.47	99	0.095
Hall	44459	33924	26.8	453	0.36	87	0.069
Lumpkin	17675	17876	35.6	340	0.68	41	0.081
White	16152	33915	73.1	244	0.053	54	0.118
Hydrologic Unit 03130002, Middle Chattahoochee River, Atlanta to Columbus							
Carroll	74757	57736	24.4	307	0.15	101	0.048
Cobb	8054	8838	38.8	25	0.11	10	0.044
Coweta	39214	39641	34.3	114	0.10	45	0.040
Douglas	9533	8983	33.3	27	0.10	11	0.039
Fulton	15476	12513	28.6	33	0.07	13	0.029
Harris	30275	18420	21.0	53	0.06	22	0.025
Heard	22983	16784	25.1	98	0.15	31	0.047
Meriwether	60489	45424	25.1	133	0.08	53	0.031
Paulding	42409	9882	8.2	58	0.05	20	0.017
Troup	30695	5581	6.4	28	0.03	11	0.013
Hydrologic Unit 03130003, Middle Chattahoochee River, Columbus to Lake W.F. George							
Chattahoochee	3580	2265	53.0	6	0.14	2	0.056
Marion	25465	12902	10.6	256	0.85	99	0.330
Muscogee	3801	418	9.3	1	0.03	1	0.012
Quitman	7952	15055	73.7	40	0.21	16	0.081
Randolph	67758	120441	60.3	317	0.19	124	0.075
Stewart	30965	47609	58.3	131	0.17	50	0.067
Talbot	28085	13551	16.6	42	0.05	17	0.021
Hydrologic Unit 03130004, Lower Chattahoochee River							
Clay	33474	53163	56.6	143	0.18	55	0.068
Early	123292	146088	32.6	391	0.13	153	0.051
Seminole	74143	51918	24.1	148	0.08	56	0.031

Note: Mass estimates are based on whole county. Concentration estimates are average event runoff concentration from agricultural lands.

Table 4-8. List of Watersheds Potentially Impacted by Agricultural Nonpoint Source Pollution in the Chattahoochee River Basin

HUC	Watershed Name - County	River Miles	§ 303(d) Priority
03130001	Soque River - Habersham	21	3
03130001	Hazel Creek - Habersham	6	3
03130001	Upper Chattahoochee River - White and Habersham	11	0
03130001	Mud Creek - Habersham	15	3
03130001	White and Mossy Creeks - Hall and White	10	3
03130001	Tesnatee Creek - White	7	0
03130001	North Chestatee River - Lumpkin	7	0
03130001	Wahoo and Little Creek - Hall, Lumpkin and White	24	0
03130001	Upper Chestatee River - Lumpkin	14	0
03130002	Dog River - Douglas and Carroll	20	0
03130002	Snake Creek - Carroll and Heard	12	0
03130004	Kolimoki Creek - Clay and Early	15	0

adversely impacting fisheries; and cause other problems with taste, odor, and color. The possible presence of pathogens including fecal bacteria that impact human health is of particular concern when waters are contaminated by waste from mammals. In addition to bacteria, cattle waste may be an important source of the infectious oocysts of the protozoan parasite *Cryptosporidium parvum*.

Pesticides

Pesticides applied in agricultural production may be insoluble or soluble and include herbicides, insecticides, miticides and fungicides. Their primary transport mode is direct surface runoff, either in dissolved form or attached to sediment particles. Some pesticides may cause acute and chronic toxicity problems in the water or throughout the entire food chain. Others are suspected human carcinogens, although the use of these pesticides has generally been discouraged in recent years.

Use of agricultural pesticides/herbicides within the basin is described in Stell *et al.* (1995). For the Flint and Chattahoochee basins combined, data compiled from the Georgia Herbicide Use Survey Summary (Monks and Brown, 1991) indicate that bentazon, paraquat, 2,4-DP, methanearsonates (MSMA/DSMA), alachlor, and pendimethalin were used to treat the largest number of acres (from 307,000 to 205,000 acres); and alachlor, MSMA/DSMA, fluometuron, atrazine, metolachlor, and bentazon were applied in the greatest quantities (from 506,000 to 185,000 pounds of active ingredient). Since 1990, the use of alachlor in Georgia has decreased dramatically (about 98 percent) in response to market conditions, as peanut wholesalers will no longer buy peanuts treated with alachlor. Metolachlor, rather than alachlor, is now being applied to peanuts.

Non-herbicide pesticide use is difficult to estimate. According to Stell *et al.* (1995), pesticides other than herbicides are currently used only when necessary to control some type of infestation (nematodes, fungi, insects), and chlorothalonil, aldicarb, chlorpyrifos, methomyl, thiodicarb, carbaryl, acephate, fonofos, methyl parathion, terbufos, disulfoton, phorate, triphenyltin hydroxide (TPTH), and synthetic pyrethroids / pyrethrins are commonly used. Application periods of the principal agricultural pesticides span the calendar year in the basin; however, agricultural pesticides are applied most intensively and on a broader range of crop types from March 1 to September 30 in any given year.

It should be noted that past uses of persistent agricultural pesticides which are now banned may continue to impact water quality within the basin, particularly through residual concentrations present in bottom sediments. The survey of pesticide concentration data by Stell *et al.* (1995) found that nearly 56 percent of the analyses in water and sediment having concentrations at or above minimum reporting levels were for two groups: DDT and metabolites, and chlordane and related compounds (heptachlor, heptachlor epoxide), while dieldrin was also frequently detected. All these pesticides are now banned by USEPA for use in the United States, but may persist in the environment for long periods of time.

4.1.2.2 Nonpoint Sources from Urban, Industrial and Residential Lands

Water quality in urban waterbodies is the result of both point source discharges and the impact of diverse land activities in the drainage basin (i.e., nonpoint sources). One of the most important sources of environmental stressors in the Chattahoochee basin, and particularly in the developed and rapidly growing areas around Atlanta, Lake Lanier, and Columbus, is diffuse runoff from urban, industrial, and residential land uses (jointly referred to as “urban runoff”). Nonpoint source contamination can lead to impairment in streams draining extensive commercial and industrial areas, where stormwater runoff, unauthorized discharges, and accidental spills may contribute to pollutant loading. Wet weather urban runoff can carry high concentrations of many of the same pollutants found in point source discharges, such as oxygen demanding waste, suspended solids, synthetic organic chemicals, oil and grease, nutrients, lead and other metals, and bacteria. The major difference is that urban runoff only occurs intermittently, in response to precipitation events.

The characteristics of nonpoint urban nonpoint sources of pollution are generally similar to those of NPDES permitted stormwater discharges (Section 4.1.1.2). Separate stormwater systems, however, are typically found in developed areas with high imperviousness and, frequently, sanitary sewer systems. Nonpoint urban sources of pollution include drainage from some builtup areas with similar characteristics, but also includes less highly developed areas with greater amounts of pervious surfaces. Nonpoint urban runoff is likely to include a larger percentage of drainage from areas including lawns, gardens, and septic tanks, all of which may be sources of nutrient load.

At present, little site-specific data are available to quantify loading in nonpoint urban runoff in the Chattahoochee River Basin, although estimates of loading rates by land use types have been widely applied in other areas. Peters and Kandell (1997) present a water quality index for streams in the Atlanta region, based primarily on nutrients and nutrient-related parameters because data for metals, organics, biological conditions, and suspended sediment were generally unavailable. They report that the annual average index of water quality conditions generally improved at most long-term monitoring sites between 1986 and 1995. However, conditions markedly worsened between 1994 and 1995 at several sites where major development was ongoing.

Urban and suburban land uses are also a potential source of pesticides and herbicides through application to lawns and turf, roadsides, and gardens and beds. Stell *et al.* (1995) provide a summary of usage in the Atlanta Metropolitan Statistical Area (MSA). The herbicides most commonly used by the lawn-care industry are combinations of dicamba, 2,4-D, mecoprop (MCPP), 2,4-DP, and MCPA, or other phenoxy-acid herbicides, while most commercially available weed control products contain one or more of the following compounds: glyphosphate, methyl sulfometuron, benefin (benfluralin), bensulide, acifluorfen, 2,4-D, 2,4-DP, or dicamba. Atrazine was also available for purchase until it was restricted by the State of Georgia on January 1, 1993. The main herbicides used by local and State governments are glyphosphate, methyl sulfometuron, MSMA, 2,4-D, 2,4-DP, dicamba, and chlorsulforon. Herbicides are used for preemergent control of crabgrass in February and October, and in the summer for postemergent control. Data from the 1991 Georgia Pest Control Handbook (Delaplane, 1991) and a survey of CES and SCS personnel conducted by Stell *et al.* indicate that several insecticides could be considered ubiquitous in urban/suburban use, including chlorpyrifos, diazinon, malathion, acephate, carbaryl, lindane, and dimethoate. Chlorothalonil, a fungicide, is also widely used in urban and suburban areas.

Stell *et al.* estimated that there are about 190 mi^2 of lawns in the Atlanta MSA part of the Chattahoochee and Flint basins, of which home owners apply pesticides to about 120 mi^2 and the lawn care industry applies pesticides to about 23 mi^2, with the remainder of lawns untreated. Other types of urban/suburban land receiving pesticide treatment include golf courses, roadsides, local government land, parks, industrial land, and schools.

Urban and residential stormwater also potentially includes pollutant loads from a number of other terrestrial sources:

> **Septic Systems**. Poorly sited and improperly operating septic systems can contribute to the discharge of pathogens and oxygen-demanding pollutants to receiving streams. This problem is addressed through septic system inspections by the appropriate County Health Department, extension of sanitary sewer service and local regulations governing minimum lot sizes and required pump-out schedules for septic systems.
>
> **Leaking Underground Storage Tanks**. The identification and remediation of leaking underground storage tanks is the responsibility of the EPD Land Protection Branch. Petroleum hydrocarbons and lead are typically the pollutants associated with LUSTs.

4.1.2.3 Nonpoint Sources from Forestry

By area, forest is the dominant land cover in the Chattahoochee Basin, accounting for 73% of land cover in 1991. Undisturbed forest land is generally associated with low rates of stressor loading compared to other land uses, and conversion of forest to urban/residential land uses is often associated with water quality degradation. Within the Chattahoochee basin, the area classified as commercial forest land has decreased by approximately 82,000 acres since 1982. Silvicultural operations may also serve as sources of stressors, particularly excess sediment loads to streams, when proper management practices are not followed. From a water quality standpoint, woods roads pose the greatest potential threat of any of the typical forest practices. It has been documented that 90 percent of the sediment that entered streams from a forestry operation was directly related to either poorly located or poorly constructed roads. Estimates in Georgia are that there are approximately 3,000 annual harvesting operations conducted in the state so the potential impact to water quality from erosion and sedimentation is great if Best Management Practices (BMPs) are not adhered to.

Silviculture is also a potential source of pesticides / herbicides. According to Stell *et al.* (1995), pesticides are mainly applied during site preparation after clear-cutting and during the first few years of new forest growth. Site preparation occurs on a 25-year cycle on most pine plantation land, so the area of commercial forest with pesticide application in a given year is relatively small. The herbicides glyphosate (Accord), sulfometuron methyl (Oust), hexazinone (Velpar), imazapyr (Arsenal), and metsulfuron methyl (Escort) account for 95% of the herbicides used for site preparation to control grasses, weeds, and broadleaves in pine stands. Dicamba, 2,4-D, 2,4,-DP (Banvel), triclopyr (Garlon), and picloram (Tordon) are minor use chemicals used to control hard to kill hardwoods and kudzu. The use of triclopyr and picloram has decreased since the early 1970's. Most herbicides are not mobile in the soil and are targeted to plants, not animals. Control of insects and diseases are not widely practical except in commercial forest tree nurseries which is an extremely minor land use. Insects are controlled by chlorpyrifos, diazinon, malathion, acephate, carbaryl, lindane, and dimethoate. Diseases are controlled using chlorothalonil, dichloropropene, and mancozeb. Applications made following the label and with regard to BMPs pose no threat to water quality.

4.1.2.4 Atmospheric Deposition

Atmospheric deposition can be a significant source of nitrogen and acidity in watersheds. Nutrients from atmospheric deposition, primarily nitrogen, are distributed throughout the entire basin in precipitation. The primary source of nitrogen in atmospheric deposition is nitrogen oxide emissions from combustion of fossil fuels. The rate of atmospheric deposition is a function of topography, nutrient sources, and spatial and temporal variations in climatic conditions.

Frick *et al.* (1996) report estimates of nitrogen loading from atmospheric deposition to the Chattahoochee River Basin as of 1990. Over the whole Chattahoochee basin (Georgia, Alabama, and Florida) they estimated an annual input of approximately 10,000 tons of nitrogen via atmospheric deposition, distributed as follows:

Hydrologic unit code	Subbasin Name	Atmospheric Deposition (tons of N per year)
03130001	Upper Chattahoochee	1,900
03130002	Middle Chattahoochee, Atlanta to Columbus	3,600
03130003	Middle Chattahoochee, Columbus to Lake George	3,400
03130004	Lower Chattahoochee	1,500

Data are not available nationally to estimate phosphorus input from atmospheric deposition; however, this component is expected to be of minor significance (Frick et al., 1996).

Atmospheric deposition may also be a source of certain mobile toxic pollutants. In particular, mercury found in fish in the lower Chattahoochee basin is thought to derive in part from atmospheric deposition, enhanced by the fact that Coastal Plain sites are characterized by physicochemical settings that enhance the formation of biologically available methylmercury

(Couch, 1997). Atmospheric deposition also contributes small background loads of PCBs and other organic chemicals.

4.1.3 Flow and Temperature Modification

Many species of aquatic life are adapted to specific flow and temperature regimes. In addition, both flow and temperature affect the dissolved oxygen balance in water, and changes in flow regime can have important impacts on physical habitat. Temperature is particularly critical for the coldwater trout fishery. Georgia is located at the extreme southern edge of trout habitat, and therefore many trout waters approach or exceed maximum tolerable temperatures during the hottest summer months, even under natural conditions. Trout need cold water to survive and reproduce well, so any practices that cause stream warming can have adverse effects.

Thus, flow and temperature modifications can be important environmental stressors. They also interact with one another to affect the oxygen balance: Flow energy helps control reaeration rate, while water temperature controls the solubility of dissolved oxygen, and higher water temperatures reduce oxygen solubility and thus tend to reduce dissolved oxygen concentrations. Further, increased water temperature increases the rate of metabolic activity in natural waters, which in turn may increase oxygen consumption by aquatic species.

Natural flows in the Chattahoochee have been altered by the construction of numerous dams. With the completion of Buford Dam in 1956, 48 miles upstream from Atlanta and forming Lake Sidney Lanier, the Chattahoochee River downstream became a fully flow regulated river. Flow regulation by dams for hydropower and other uses control flow rates in most of the Chattahoochee.

The segments of the Chattahoochee between Buford Dam and West Point Lake (HUC 03130001 and 03130002) are the subject of the Chattahoochee River Modeling Project (Law Environmental, 1994). As part of this project, current knowledge regarding the effects of dams within this segment of the river were summarized:

Buford Dam and releases from Lake Sidney Lanier typically dominate flows in the Chattahoochee. The maximum discharge rate from Buford Dam during peak power generation is about 8,400 ft^3/s. Each period of hydroelectric power generation moves water downstream in the form of a wave or pulse, which can be observed at gaging stations along the entire reach of the river between Buford Dam and West Point Lake, a distance of more than 100 river miles (USGS, 1979).

The cycle of dam releases follows a weekly schedule with five weekdays of short periods of power generation followed by two weekend days with little or no generation. During a typical week, power is generated for several hours each weekday and infrequently on weekends. The main turbines are operated for peaking power during the middle of the day; during off peak hours a small turbine is operated to maintain 550 cfs for water supply and downstream water quality. Superimposed on these daily and weekly cycles is an annual pattern caused by operations for flood control. During the fall more water is released to provide flood storage for winter and spring rainfall runoff.

Lake Lanier undergoes thermal stratification during the early summer, with warm surface waters overlying colder bottom waters. Stratification reduces internal circulation of water, and limits the vertical movement of biological or chemical material and dissolved oxygen.

Consequently, low dissolved oxygen concentrations at greater depths occur during certain periods of the year. Hydroelectric power generation at Buford Dam withdraws water from these depths resulting in cold water discharges that can be low in dissolved oxygen between July and December. After the period of summer thermal stratification there is usually a fall turnover when the temperature stratification is broken and the lake becomes fully mixed by late December. This cycle of stratification and destratification occurs annually and affects the water quality of releases from Buford Dam.

For these reasons, releases for hydroelectric power production can have a significant cooling effect on river temperatures below Buford Dam, especially during the period of March to November, and a warming effect during the months of December and January. During most of the year, the water temperature in the tailwater immediately downstream of Lake Lanier is normally between 7°C and 15°C except in October when temperatures may exceed 20°C. At Paces Ferry, 46 miles downstream, much of the cooling effect noted at Buford Dam has dissipated and river water temperatures more closely approximate a natural annual pattern (USGS, 1979).

The flow and water quality dynamics of the Chattahoochee River resulting from hydroelectric power generation releases at Buford Dam are shown in Figure 4-14, representing in-stream monitoring data collected in August 1993 at State Road 20, less than three miles below the dam. The graph shows sudden changes in depth, water temperature, and dissolved oxygen. Water depth is directly related to river flow and the rapidly rising depths during the week indicate releases from Buford Dam. The data show that the power wave at State Road 20 produces a two to three degree change in water temperature and a 2 mg/l change in dissolved oxygen over several hours during weekday operation.

Morgan Falls Dam impounds Bull Sluice Lake at RM 312.60, with a surface water elevation of approximately 866 ft msl. The lake is characterized by low flow velocities, broad shallow pools, and embayments, and has experienced extensive sediment deposition since its creation in 1904. Sediment deposition has decreased the average depth to approximately 5 feet and has created wetlands attractive to recreation and fishing in the lake. The broad and shallow nature of Bull Sluice Lake can elevate lake water temperatures and temperatures in subsequent releases from Morgan Falls Dam.

Georgia Power Company operates the hydroelectric power plant at Morgan Falls Dam, and also augments weekend low flows (created by operations at Buford Dam) for downstream water supply. A contract exists between the City of Atlanta and the Georgia Power Company requiring Georgia Power to release water according to a specified schedule to provide a minimum flow of 750 cfs at all times at the City of Atlanta water intake (RM 300.52) and flows in excess of 750 cfs during the daytime (City of Atlanta and Georgia Power Company, 1957).

Morgan Falls Dam began producing electric power in October, 1904. Morgan Falls Dam is a “run-of-the-river” hydroelectric power facility with limited storage; thus it only partially regulates river flows. Like Buford Dam, power generation at Morgan Falls Dam can affect downstream river flows and temperature. Its impact on flow and water temperature is, however, considered to be minimal (USGS, 1979).

Water temperatures within the Chattahoochee River Modeling Project study area are determined by the combined effects of dam operation and tributary water temperature. Above

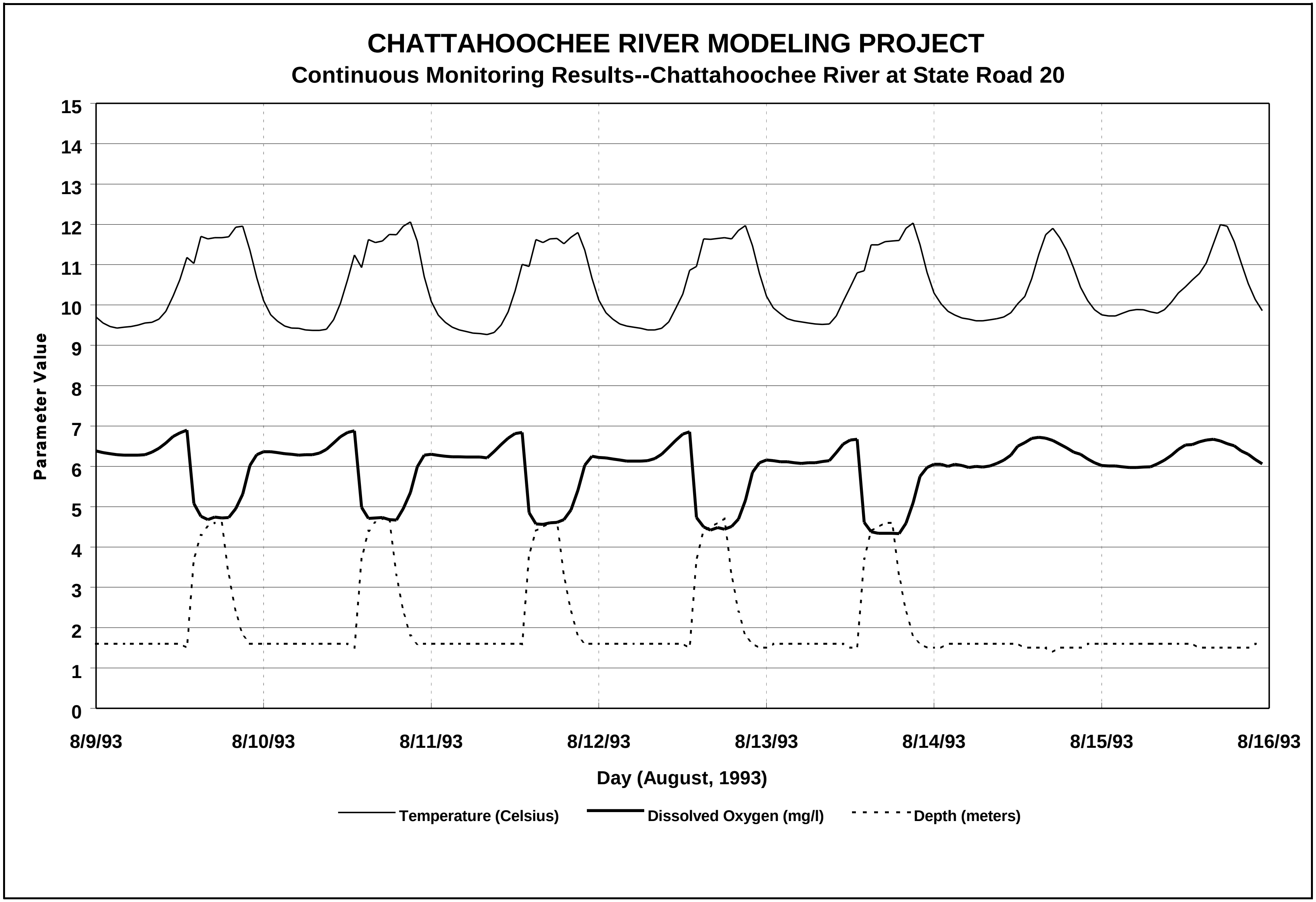


Figure 4-14. Dynamic Water Quality Resulting from Buford Dam Releases

Morgan Falls Dam, the cold water discharge from Buford Dam constitutes a large percentage of the river flow and tributary inflows have little impact on temperature during routine dry-weather operations. However, storm events which occur during periods of minimum releases from Buford Dam have caused river water temperatures to increase to a point where trout were stressed or even died (ARC, 1992). Impervious surfaces in urban areas increase water temperatures in stormwater runoff. The temperature profile in the river is thus determined by a combination of dam operation and nonpoint stormwater runoff.

Within Hydrologic Unit 03130002, dissolved oxygen violations are also noted below West Point Dam, attributable to hydropower releases of bottom water. In Hydrologic Unit 03130004 similar problems are associated with hydropower releases from Lake W. F. George.

4.1.4 Physical Habitat Alteration

Many forms of aquatic life are sensitive to physical habitat disturbances. Probably the major disturbing factor is erosion and loading of excess sediment, which changes the nature of the stream substrate. Trout waters are particularly sensitive to sedimentation as trout need clean substrate to survive and reproduce well. Thus, any land use practices that cause excess sediment input can have significant impacts. Because of rapid development in the mountainous areas, the quality of trout streams is often compromised by sedimentation from land disturbing activities.

Physical habitat disturbance is also evident in many urban streams. Increased impervious cover in urban areas an result in high flow peaks, which increase bank erosion. In addition, construction and other land disturbing activities in these areas often provides an excess sediment load, resulting of choking of the natural substrate and physical form of streams with banks of sand and silt.

Another important form of physical habitat disruption is loss of riparian tree cover. Under natural conditions, smaller streams in Georgia are shaded by a tree canopy. If this canopy is removed the resulting direct sunlight can result in increased water temperatures with adverse effects on native aquatic life. Habitat disturbance through construction of small impoundments can also raise water temperatures.

4.2 Stressor Summary

Section 4.1. described the major sources of loads of pollutants (and other types of stressors) to the Chattahoochee basin. What happens in the river, however, is often the result of the combined impact of many different types of loading, including point and nonpoint sources. For instance, excess loads of nutrients may represent the net effect of wastewater treatment plant discharges, runoff from agriculture, runoff from residential lots, and other sources. Accordingly, Section 4.2 brings together the information contained in Section 4.1. to focus on individual stressor types, as derived from all sources.

4.2.1 Nutrients

All plants require certain nutrients for growth, including the algae and rooted plants found in lakes, rivers, and streams. Nutrients required in the greatest amounts include nitrogen and phosphorus. Some loading of these nutrients is needed to support normal growth of aquatic plants, an important part of the food chain. Too much loading of nutrients can, however, result in an over-abundance of algal growth with a variety of undesirable impacts. The condition of excessive nutrient-induced plant production is known as eutrophication, and waters affected by this condition are said to be eutrophic. Eutrophic waters often experience dense blooms of algae, which can lead to unaesthetic scums and odors and interfere with recreation. In addition, overnight respiration of living algae, and decay of dead algae and other plant material, can deplete oxygen from the water, stressing or killing fish. Eutrophication of lakes typically results in a shift in fish populations to less desirable, pollution tolerant species. Finally, eutrophication may result in blooms of certain species of blue-green algae which have the capability of producing toxins.

For freshwater aquatic systems, the nutrient which is in the shortest supply relative to plant demands is usually phosphorus. Phosphorus is then said to be the limiting nutrient, because the concentration of phosphorus limits potential plant growth. Control of nutrient loading to reduce eutrophication thus focuses on phosphorus control.

Point and nonpoint sources to the Chattahoochee also discharge large quantities of nitrogen, but nitrogen is usually present in excess of amounts required to match the available phosphorus. Nitrogen (unlike phosphorus) is also readily available in the atmosphere and ground water, so it is not usually the target of management to control eutrophication in fresh water. The bulk of the nitrogen in fresh water systems is found in one of three ionic forms: ammonium (NH_4^+), nitrite (NO_2^-), and nitrate (NO_3^-). Nitrite and nitrate are more readily taken up by most algae, but ammonia is of particular concern because it can be toxic to fish and other aquatic life. Accordingly, wastewater treatment plant upgrades have focused on reducing the toxic ammonia component of discharges, with corresponding increase in the nitrate fraction.

The major sources of nutrient loading in the Chattahoochee basin are wastewater treatment facilities, urban runoff and stormwater, and agricultural runoff. Concentrations found within rivers and lakes of the Chattahoochee basin represent a combination of a variety of point and nonpoint source contributions.

Point source loads can be quantified from permit and effluent monitoring data, but nonpoint loads are difficult to quantify. Rough estimates of average nutrient loading rates from agriculture are available (Section 4.1.2.1); however, nonpoint loads from urban/residential sources in the basin have not yet been quantified. The net load arising from all sources may, however, be examined from instream monitoring. Long term trends in nutrients within the Chattahoochee River Basin for 1972–90 are summarized by Frick *et al.* (1996). An even more informative picture is obtained by examining results from EPD long-term trend monitoring stations from 1968 to present.

Trends in loading of total phosphorus can be seen by examining results at three stations: Chattahoochee River at Cobb Co. water intake (upstream of Atlanta just below Morgan Falls Dam); Chattahoochee River at State Road 92 (below the Atlanta metropolitan sewage outfalls), and Chattahoochee River at Omaha (just above Lake W. F. George).

Upstream of Atlanta, phosphorus loading is due to a combination of nonpoint sources and loading from several smaller wastewater treatment plants above Morgan Falls Dam (Figure 4-15). The figure shows individual trend-monitoring measurements since 1969 as points.

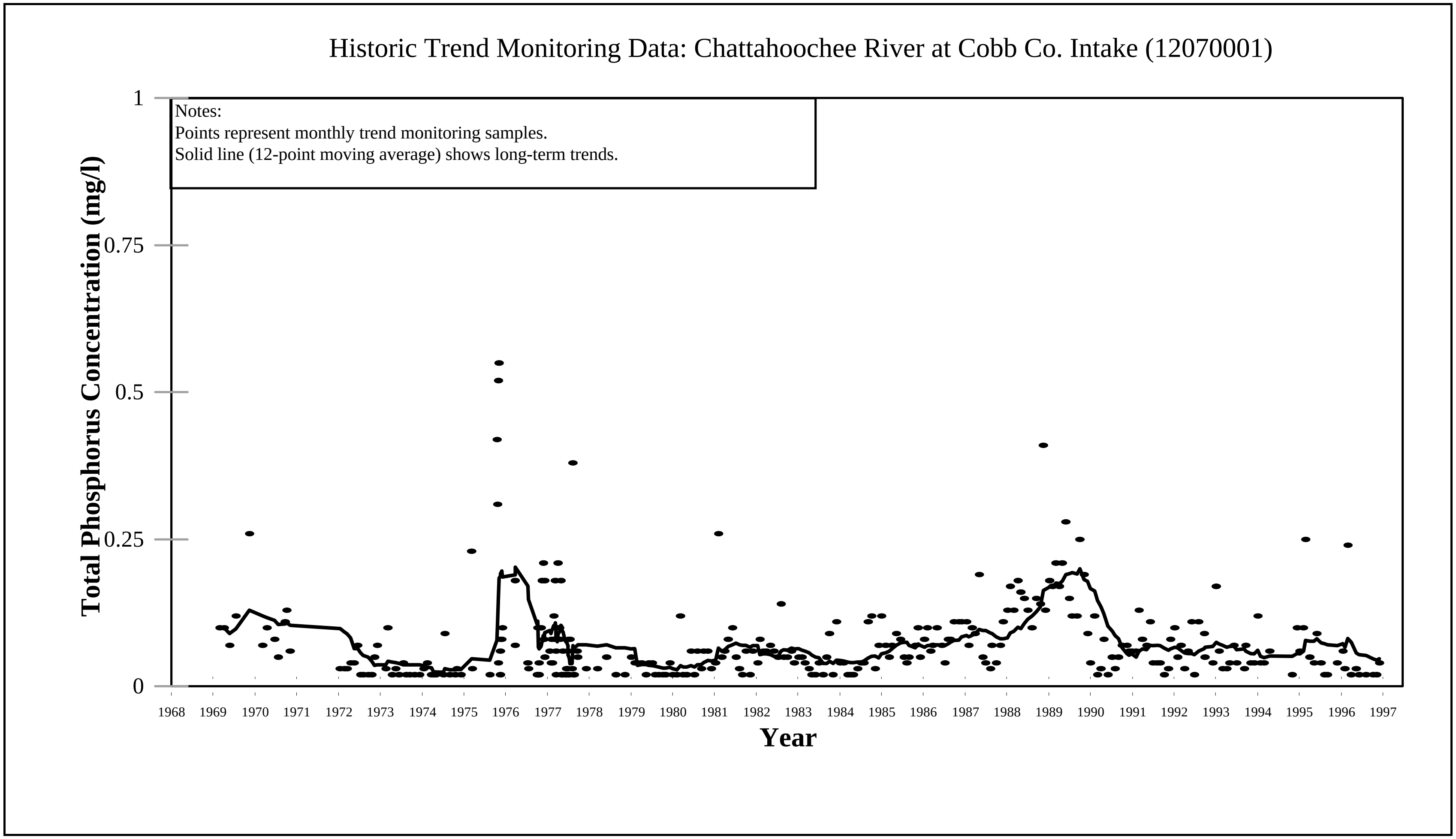


Figure 4-15. Total Phosphorus Concentration, Chattahoochee River at Cobb Co. Intake above Atlanta

Superimposed on these points is a moving-average line, representing long-term trends. The median (50th percentile) phosphorus concentration observed at this station is 0.05 mg/l, and the maximum observed was 0.55 mg/l (in 1975). A moderate increasing trend between 1980 and 1989 coincides with population growth and expansion of the Fulton County Big Creek wastewater treatment plant above Morgan Falls Dam. This trend was reversed in 1990, reflecting EPD requirements on wastewater treatment plants and legislation restricting the use of phosphate detergents.

In the Chattahoochee at State Road 92, below Atlanta, phosphorus concentrations are much higher due to input from the Atlanta area wastewater treatment plans (Figure 4-16). For 1968 through 1985, the median of total phosphorus concentration observations instream was 0.44 mg/l, and the maximum observed was 3.6 mg/l. During 1986 to 1988, concentration increased, due primarily to diversion of Atlanta wastewater from the headwaters of the Flint basin to the Chattahoochee basin plants. Since 1989, both the magnitude and seasonal variability of phosphorus concentrations at this station have declined dramatically, reflecting the extensive treatment plant upgrades required by EPD for phosphorus removal coupled with legislation restricting use of phosphate detergents. For the period 1995-96, the median concentration at this station was 0.11 mg/l, or only one-fourth of the concentrations observed prior to 1986.

Below Atlanta, the Chattahoochee passes through a series of major impoundments, beginning with West Point Lake. Because phosphorus is taken up by plants and also tends to sorb to sediment particles, substantial amounts of phosphorus load are removed within these reservoirs. At the trend monitoring station at Omaha, just above Lake W. F. George, total phosphorus concentrations have remained consistently moderate (Figure 4-17), with a median of 0.08 mg/l, despite inputs upstream from the Columbus wastewater treatment plant.

Trends in nitrogen loading have also been affected by treatment plant upgrades. A plot of ammonia concentration at State Road 92 (Figure 4-18) shows a dramatic drop in response to the 1989 treatment plant upgrades, going from a median of 0.91 mg/l (as N) in 1985-88 to a median of 0.22 mg/l in 1993-96. Total nitrite-plus-nitrate concentrations (Figure 4-19), in contrast, have shown a long-term upward trend, reflecting wastewater treatment plant conversion of ammonia to nitrite/nitrate, as well as increased urban runoff contributions as population and development have increased.

4.2.2 Oxygen Depletion

Oxygen is required to support aquatic life, and Georgia water quality standards specify minimum and daily average dissolved oxygen concentration standards for all waters. Problems with oxygen depletion in rivers and streams of the Chattahoochee basin are associated with oxygen demanding wastes from point and nonpoint sources and hydropower operations which release oxygen-depleted bottom water from reservoirs. Historically, the greatest threat to maintaining adequate oxygen levels to support aquatic life has come from the discharge of oxygen-demanding wastes from wastewater treatment plants. Treatment upgrades and more stringent permit limits have reduced this threat substantially.

Figure 4-20 shows the long-term trends in dissolved oxygen concentrations in the Chattahoochee at State Road 92, below Atlanta. There is a general improving trend, with few violations of the dissolved oxygen standard of 5 mg/l (daily average) in recent years. The most

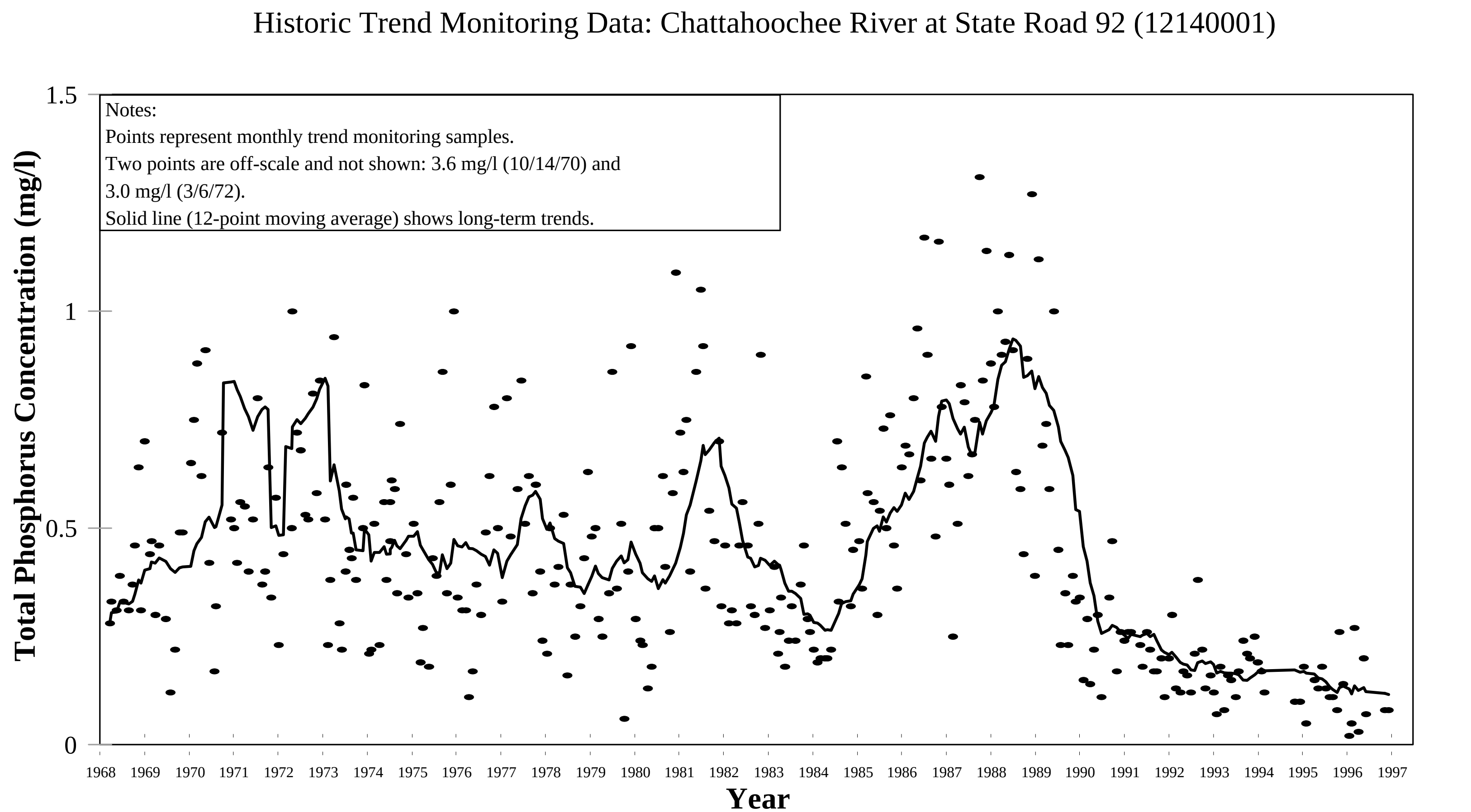


Figure 4-16. Total Phosphorus Concentration, Chattahoochee River at Hwy. 92 below Atlanta

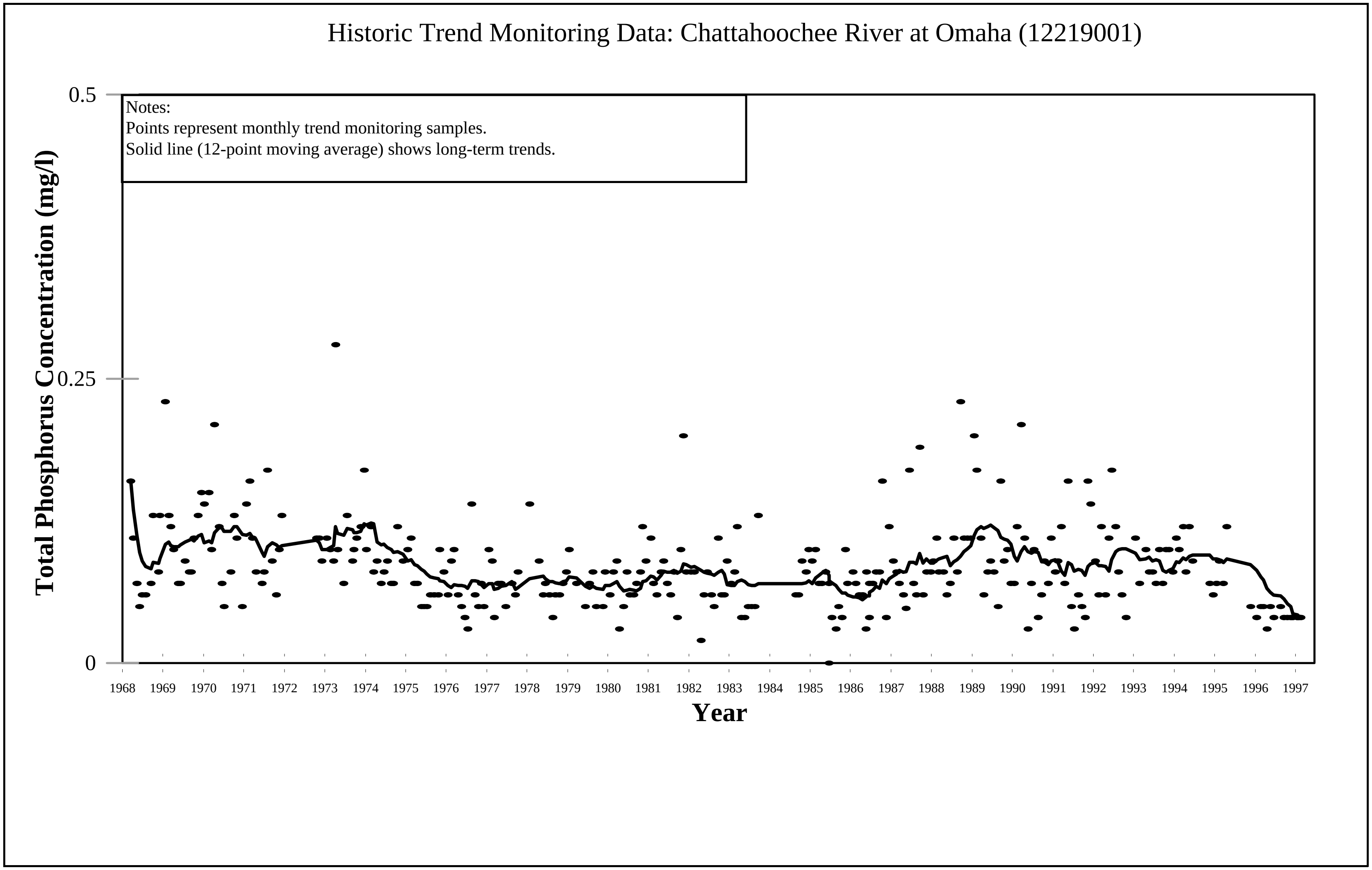


Figure 4-17. Total Phosphorus Concentration, Chattahoochee River at Omaha above Lake W. F. George

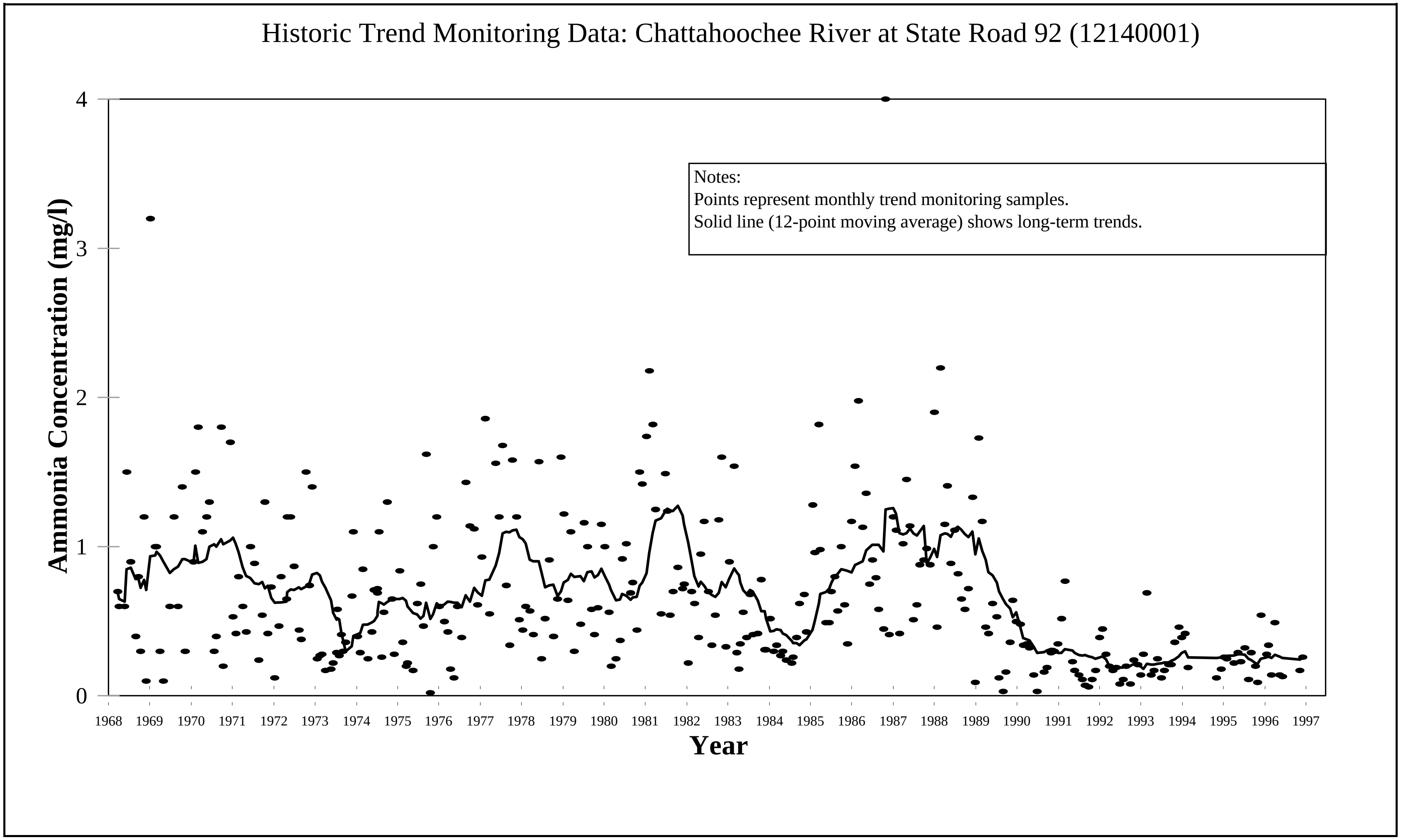


Figure 4-18. Ammonia Concentration (as N), Chattahoochee River at Hwy. 92 below Atlanta

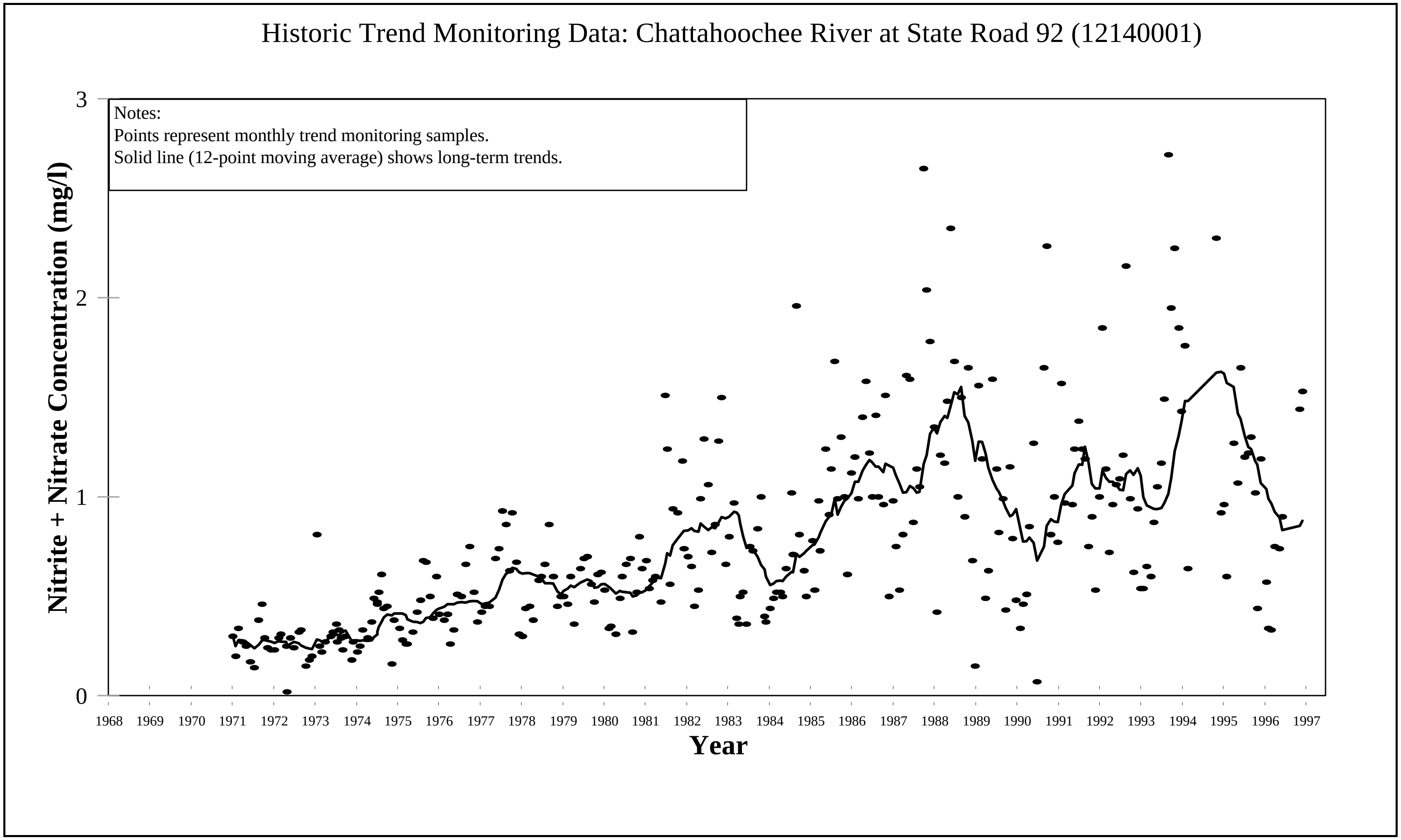


Figure 4-19. Nitrite plus Nitrate Concentration (as N), Chattahoochee River at Hwy. 92 below Atlanta

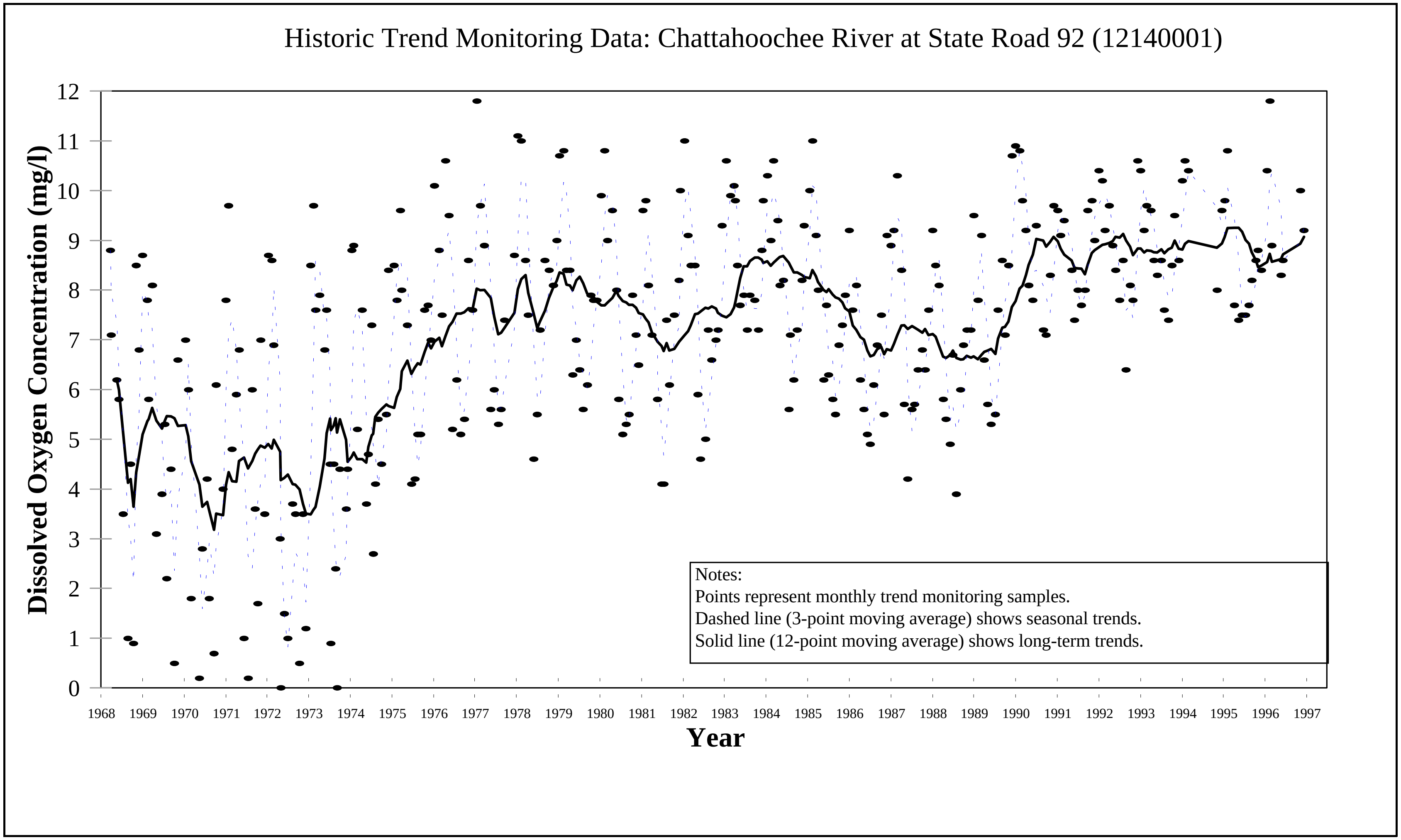


Figure 4-20. Dissolved Oxygen Concentration, Chattahoochee River at Hwy. 92 below Atlanta

dramatic improvement occurred between 1973 and 1975, associated with upgrades of the Atlanta and Cobb Co. wastewater treatment plants.

The most significant oxygen depletion problems currently observed in the Chattahoochee River are associated with bottom water discharges from Lake Lanier during late summer and fall (August to November). This water naturally reoxygenates during turbulent flow in the river; however, dissolved oxygen concentrations below the water quality standard extend for several miles downstream in summer months during periods of power generation. An important goal of the ongoing Chattahoochee River Modeling Project (CRMP) is to provide a time-variable modeling system which can support regulatory decision making for dissolved oxygen and other issues on the reach of the Chattahoochee between Buford Dam and Franklin, Georgia.

Dissolved oxygen violations are also associated with hydropower releases of bottom water from West Point Dam and W.F. George Lock and Dam.

4.2.3 Metals

Violations of water quality standards for metals (e.g., lead, copper, zinc) were the second most commonly listed causes of non-support of designated uses in the 1994-95 water quality assessment, after fecal coliforms. In most cases, these metals are attributed to nonpoint urban runoff and stormwater. Point sources also contribute metals loads; however, major point sources of metals in the Chattahoochee basin (wastewater treatment plants and certain industrial discharges) have been brought into compliance with permit limits, leaving the more-difficult-to-control nonpoint sources as the primary cause of impairment.

It should be noted that sample data on metals in many streams is rather sparse, and there are concerns with quality of some of the older data. While urban runoff appears to be the primary source of loading of these stressors, loading rates have not been quantified and will require additional study.

Primarily within the Coastal Plain, mercury is a metal of concern which has led to several fish consumption guidelines. Ultimate sources of loading of this mercury may include urban runoff, atmospheric deposition, and natural background.

4.2.4 Fecal Coliform Bacteria

Violations of the standard for fecal coliform bacteria were the most commonly listed cause of non-support of designated uses in the 1994-95 water quality assessment. Fecal coliform bacteria are monitored as an indicator of fecal contamination and the possible presence of human bacterial and protozoan pathogens in water. Fecal coliform bacteria may arise from many of the different point and nonpoint sources discussed in Section 4.1. Human waste is of greatest concern as a potential source of bacteria and other pathogens. One primary function of wastewater treatment plants is to reduce this risk through disinfection. Observed violations of the fecal coliform standard below several wastewater treatment plants on the Chattahoochee River have generally been rapidly corrected in recent years. Combined sewer overflows, which may discharge dilute untreated sewage directly to streams during wet weather, have been a source of intermittent fecal coliform contamination in the Atlanta and Columbus areas, but are now being addressed through control strategies, as discussed in Section 4.1.1.2.

Figure 4-21 shows fecal coliform concentrations measured at the trend monitoring station in the Chattahoochee at State Road 92, downstream of Atlanta. Note that the left-hand axis uses a

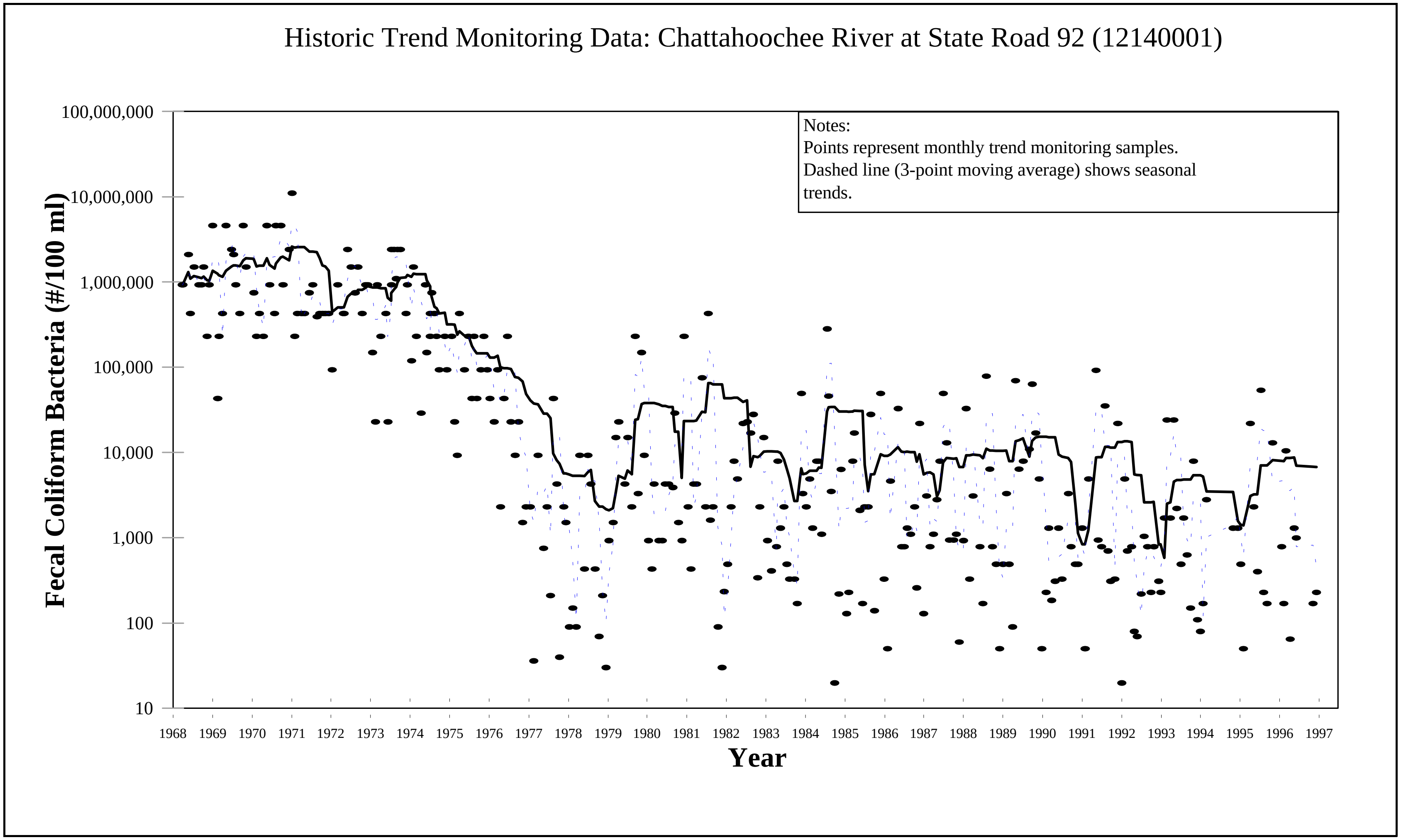


Figure 4-21. Fecal Coliform Bacteria Concentration, Chattahoochee River at Hwy. 92 below Atlanta

logarithmic scale. Prior to 1976, fecal coliform concentrations were frequently greater than 100,000 per 100 ml, representing significant water quality degradation and a potential threat to human health (the current standard for fecal coliform is a 30-day geometric mean of 200 per 100 ml in recreational waters; in other waters the standard is a 30-day geometric mean of 200 per 100 ml during May through October, and 1000 per 100 ml in November through April). Significant improvement (99.9% reduction) in fecal coliform concentrations occurred during the 1970's as secondary treatment of wastewater was implemented. During 1995-97, median fecal coliform concentration was 490 per 100 ml at this station, although individual concentrations as high as 54,000 per 100 ml were noted. Similar improvements can be seen in the time series of fecal coliform concentrations in the Chattahoochee at Omaha, downstream of Columbus (Figure 4-22). Here, the median concentration during 1995-97 was 330 per 100 ml.

As point sources have been brought under control, nonpoint sources have become increasingly important as potential sources of fecal coliform bacteria. Nonpoint sources may include

- Agricultural nonpoint sources, including concentrated animal operations and spreading and/or disposal of animal wastes may introduce fecal contamination into waterbodies. Spreading of wastes from poultry operations in HUC 03130001 may be of particular concern.

- Runoff from urban areas transports surface dirt and litter which may include both human and animal fecal matter, as well as a fecal component derived from sanitary sewer overflows. Urban nonpoint sources of pollution appear to present the greatest problem for fecal coliform loading in the metropolitan Atlanta area, where most smaller streams show violations of the fecal coliform standard. Significant, but lesser problems with fecal coliform loading in urban runoff have also been noted in Columbus, Gainesville, LaGrange, and other smaller urban areas.

- Urban and rural input from failed or ponding septic systems may also be a source of fecal coliform bacteria.

4.2.5 Synthetic Organic Chemicals

Synthetic organic chemicals (SOCs) include pesticides, herbicides, and other man-made toxic chemicals. SOCs may be discharged to waterbodies in a variety of ways, including:

- Industrial point source discharges;

- Wastewater treatment plant point source discharges, which often include industrial effluent as well as SOCs from household disposal of products such as cleaning agents, insecticides, etc.;

- Nonpoint runoff from agricultural and silvicultural land with pesticide and herbicide applications;

- Nonpoint runoff from urban areas, which may load a variety of SOCs, including horticultural chemicals, termiticides, etc.;

- Illegal disposal and dumping of wastes.

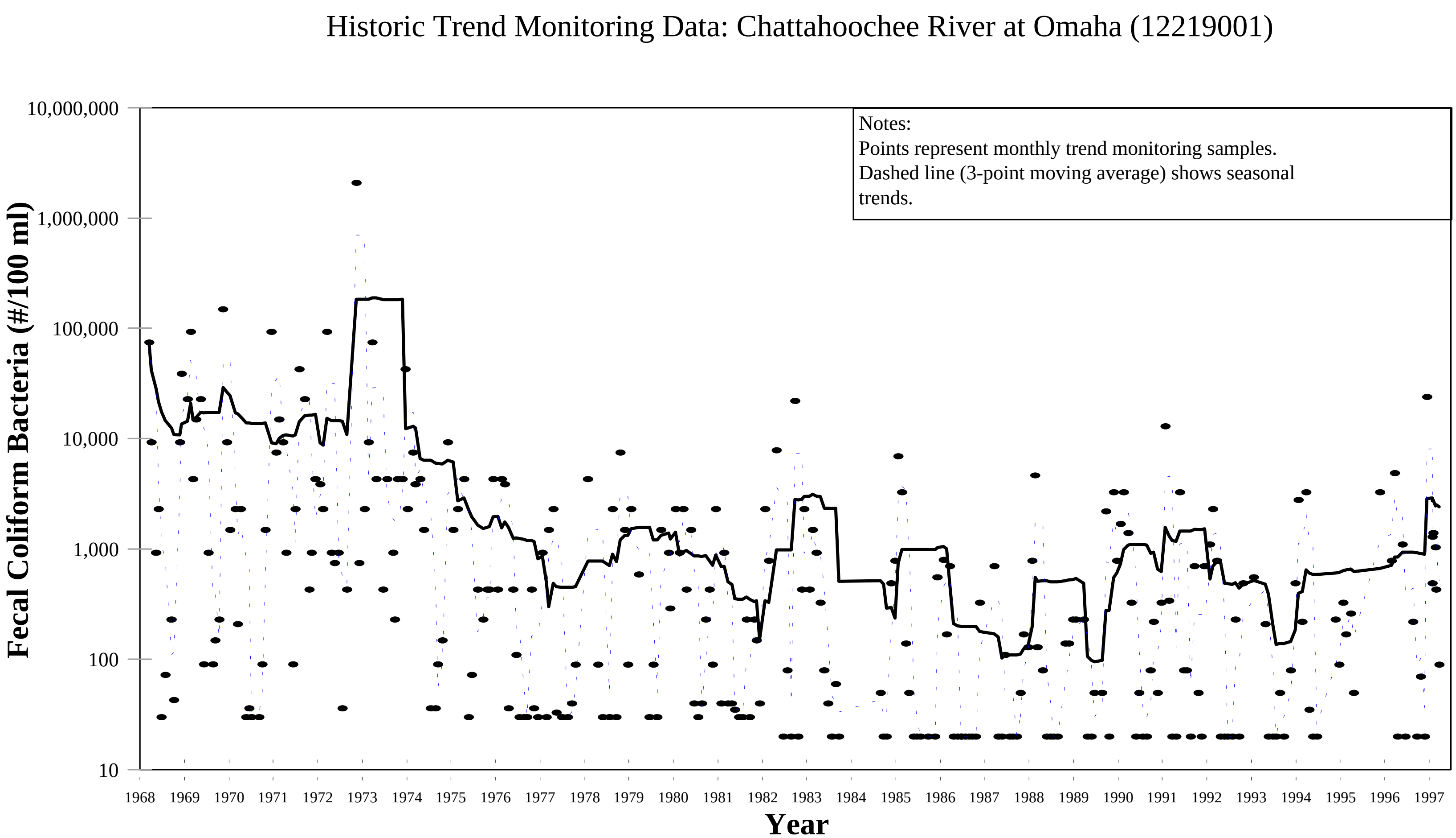


Figure 4-22. Fecal Coliform Bacteria Concentration, Chattahoochee River at Omaha above Lake W. F. George

To date, synthetic organic chemicals have not been detected in the surface waters of the Chattahoochee River Basin in problem concentrations. It should be noted, however, that the majority of monitoring has been targeted to waters below point sources where potential problems were suspected. Agricultural sources were potentially important in the past, particularly from cotton production in the Coastal Plain, but risk of excess loading has apparently greatly declined with a switch to less persistent pesticides. Recent research by USGS (Stell et al., 1995; Hippe et al., 1994) suggests pesticide/herbicide loading in urban runoff and stormwater may be of greater concern than agricultural loading, particularly in streams of the metropolitan Atlanta area.

Certain SOCs, discharged to the watershed in past decades, continue to be of concern today. In particular, PCBs and chlordane (both now banned) have resulted in fish consumption guidelines throughout the Chattahoochee mainstem from Buford Dam to Lake Seminole. These compounds, which are highly bioaccumulative, apparently enter the food chain from contaminated sediments. Urban runoff and stormwater may also play a role in continued loading of these chemicals.

4.2.6 Flow and Temperature Modification

Stress from flow modification is primarily associated with peaking hydropower operation of dams on the Chattahoochee River, and increased stormflow in smaller streams associated with development and increased impervious area. Most notably, hydropeaking operation of Buford Dam at Lake Lanier results in pulsing of flow and summer/fall releases of cool bottom water which tends to be depleted in dissolved oxygen.

The reach of the Chattahoochee River between Buford Dam and Atlanta is able to support a coldwater fishery because of releases of cold bottom waters from Lake Lanier, while natural climate conditions would not provide summer water temperatures suitable to a coldwater trout fishery. Accordingly, this stretch of the river is sensitive to increased temperature. Summer stormwater runoff from impervious urban areas around Atlanta has the potential to increase water temperatures in the river, and can be a source of stress to the trout population.

4.2.7 Sediment

Erosion and discharge of sediment can have a number of adverse impacts on water quality. First, sediment may carry attached nutrients, pesticides and metals into streams. Second, sediment is itself a stressor. Excess sediment loads can alter habitat, destroy fish spawning substrate, and choke aquatic life, while high turbidity also impairs recreational and drinking water uses. Sediment loading is of concern throughout the basin, but is of greatest concern in developing areas of metropolitan Atlanta and in the steep headwaters area above Lake Lanier. Important sources of sediment load include: construction; unpaved rural roads; streambank erosion associated with peak flows from increased impervious area and hydropower operations; dredging; agriculture; and forestry.

Within the Chattahoochee basin, the importance of agriculture as a source of sediment load relative to other sources is diminished because the percent of land in crops is relatively low, except within the flat Coastal Plan areas of the basin.

4.2.8 Habitat Degradation and Loss

In many parts of the Chattahoochee basin, support for native aquatic life is threatened by degradation of aquatic habitat. Habitat degradation is closely tied to sediment loading, and excess sediment is the main threat to habitat in rural areas with extensive land disturbing activities, as well as in urban areas where increased flow peaks and construction can choke and alter stream bottom substrates. A second important type of habitat degradation in the Chattahoochee is loss of riparian tree cover, which can lead to increased water temperatures.

Habitat degradation appears to be of greatest concern within the headwaters trout streams north of Lake Lanier, and in urban areas, especially the metropolitan Atlanta area.

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